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Handbook of

UNIONID MUSSELS

in Kansas

Harold D. Murray
A. Byron Leonard

The University of Kansas
Department of Zoology and State Biological Survey

Cover: Blue-Point Mussel (*Crenodonta peruviana costata*) on the bottom of a stream; a Black Crappie swims above, and a Muskrat sits on a log on the bank.

HANDBOOK OF

UNIONID MUSSELS

IN KANSAS

BY

HAROLD D. MURRAY

AND

A. BYRON LEONARD

Contribution from the Department of Zoology and State Biological Survey

MUSEUM OF NATURAL HISTORY
UNIVERSITY OF KANSAS
Lawrence, Kansas

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Museum
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INTRODUCTION

Purpose

The objectives of the study here reported on are to list and describe the unionid (fresh-water) mussels in Kansas, to show their distribution within the state and in North America, to provide the means for identifying unionids found in Kansas, to indicate the origin of the present populations in the state, and to appraise the ecological and economic importance of the unionid fauna. The report is designed to be useful to teachers and other non-specialists, as well as to malacologists having a professional interest in the unionids in Kansas.

Economic Importance

Because unionids are found in all bodies of permanent water—streams, ponds, and lakes—they represent an important part of the aquatic fauna of Kansas. Coker (1919) carefully considers the economics of the mussel industries that were once an important part of the economy of America.

The manufacture of buttons from the shells of fresh-water mussels began about 1891. In 1912 the income from this industry amounted to approximately $6,173,486 yearly. With the advent of plastics, the shell industry declined sharply; today, fresh-water mussel shells are used primarily for novelty work, such as charm bracelets, hat pins, belt buckles, and fancy buttons. In 1912, approximately 17,063 tons of shells were removed from the Neosho River in Kansas; this amounted to 17 per cent of the pearly products for the United States in that year. In the year 1960 in Kansas there was no commercial harvesting of unionid shells.

In the past the meats of mussels have been used for hog and poultry food as well as for human consumption; however, unsanitary conditions prevailing in shell industries discouraged people from using meats of mussel for food. More recently farmers have not utilized meats of mussel for animal food. Fisherman frequently find the putrified meats of mussels to be excellent fish-bait.

Mussels serve as food for raccoon, mink, otter, muskrat and several other mammals, and the immature mussels are frequently eaten by fishes. Baker (1918) considers the unionids as an important source of food for fishes. This subject is discussed in more detail under Predation and Parasitism (p. 30).

Of less importance in large, fast-flowing rivers, but extremely significant in small ponds and stagnant pools is the consideration of the filtering effect on the water by the mussels. Allen (1914)

estimated the siphoning rate of *Lampsilis siliquoidea* of 200 grams weight at approximately 34,560 cc. (approximately 8.8 gallons) per day!

ACKNOWLEDGMENTS

We wish to thank Dr. Henry van der Schalie, University of Michigan, for his aid in identification of the species of the genus *Crenodonta,* and to thank Drs. Frank Cross, R. E. Beer, and E. Raymond Hall, University of Kansas, for criticism of the manuscript.

Special thanks are extended to the State Biological Survey of Kansas for financial support in the preparation of illustrations.

REVIEW OF LITERATURE

In a series of publications, R. E. Call (1885-1887), Washburn College Laboratory of Natural History, listed unionids then known from Kansas. Localities were given by town and county, and in some instances by drainage systems. No description of the animals or illustrations accompanied Call's work; therefore, it is not possible to determine the validity of some of his records.

In 1906 R. E. Scammon published "The Unionidae of Kansas," in which he described the various species occurring in Kansas and published illustrations of most of them. Unfortunately, those species presently thought to be invalid records for the state are those that were not illustrated in his study. Until now Scammon's publication was the only comprehensive account of mussels in Kansas.

A thorough study of mussels occurring in a tributary of the Kansas River was made by D. S. Franzen and A. B. Leonard and in 1943 resulted in their publication, "The Mollusca of the Wakarusa River Valley." That account added much to the knowledge of the unionid fauna of the northern part of Kansas. Clark and Gillette (1911), A. E. Leonard (1943), and A. B. Leonard and A. E. Leonard (1946) have published locality records for various areas of the state.

CLASSIFICATION OF MUSSELS IN KANSAS

Fresh-water mussels belong to that large group, a phylum, of animals, termed the Mollusca. Members of the phylum, inhabiting salt water, brackish water, fresh water, and land, have the following characteristics in common: bilateral symmetry; no segmentation (except Monoplachophora); soft body covered by mantle that usually secretes calcareous shell; mouth having radula (except bivalves); dorsal heart; respiration by gill-like ctenidia or "lung"; nervous system having paired ganglia, connectives, and nerves; sexes separated or united; trochophore, veliger or glochidial larva.

The phylum Mollusca encompasses six classes (Plate 1):

CLASS MONOPLACOPHORA: Nearly bilaterally symmetrical mollusks, exhibiting internal metamerism; dorsal, monovalve shell; posteromedian anus; well developed coelomic cavities; auricles paired, metamerically arranged; nephridia metameric; nervous system primitively orthoneurous; *Neopilina, Tryblium* (figure 1).

CLASS AMPHINEURA: Chitons. Body elongate; shell of eight plates or none; head reduced; nerve ring around mouth and two pairs of ventral nerve cords; no tentacles; having radula; marine; *Chiton, Cryptochiton* (figure 2).

CLASS GASTROPODA: Snails, slugs. Shell usually spiral, reduced or absent; head distinct; foot large, flat for holdfast and creeping; visceral mass turned 180° counterclockwise (torsion) on head and foot; two or one ctenidia or replaced by secondary gills or "lung"; radula; marine, terrestrial or fresh-water; *Lymnea, Physa, Haliotis, Crepidula* (figure 3).

CLASS SCAPHOPODA: Tusk shells. Shell and mantle slenderly tubular and open at both ends; foot conical; delicate "tentacles" around mouth; no gills; having radula; marine; *Dentalium* (figure 4).

CLASS PELECYPODA: Clams, fresh-water mussels, oysters. Shell of two lateral halves, usually symmetrical having dorsal hinge ligament; mantle flattened having right and left lobes; head absent; fleshy labial palpi beside mouth; no jaws or radula; mostly marine, some fresh-water; *Pecten, Anodonta, Pholas, Sphaerium* (figure 5).

CLASS CEPHALOPODA: Squids and octopuses. Shell external, internal, or none; head large, well-developed eyes; mouth having horny jaws and radula surrounded by 8 to 10 tentacles; nerve ganglia grouped as a "brain" in cartilagelike covering; marine; *Nautilus, Sepia, Octopus* (figure 6).

The class Monoplacophora, recognized by some authors, was erected to include certain fossil mollusks and recently is considered to include the living genus *Neopilina* (Plate 1, figure 1), collected first in a deep trench off the west coast of Mexico in 1952 (Lemche, 1957). The class is unusual in several ways, but especially in that *Neopilina* shows internal segmentation. It is now thought that some mollusks are segmented, and it may be that all primitive forms were.

Mussels belong to the Class Pelecypoda, which includes four orders: Protobranchia, Filobranchia, Eulamellibranchia, and Septibranchia. All of the fresh-water mussels are in the order Eulamellibranchia; for information concerning the other orders of pelecypods, the reader is referred to Storer and Usinger (1957) or Borradaile, *et al.* (1958).

Eulamellibranchiates are characterized by having W-shaped gills, that have the lamellae of each half united by firm connections, and by having two adductor muscles of equal size. The order includes

PLATE 1

The Classes of Mollusca

FIG. 1. Class Monoplacophora. *Neopilina* in dorsal view, showing dorsal shell and growth lines. Approximately × 1.

FIG. 2. Class Amphineura. A chiton (*Cryptochiton*) in dorsal view, showing typical eight shell-plates exposed. Approximately × ⅓.

FIG. 3. Class Gastropoda. A snail (*Triodopsis*) seen in lateral view, showing the position in which the shell is carried. Approximately × 1⅓.

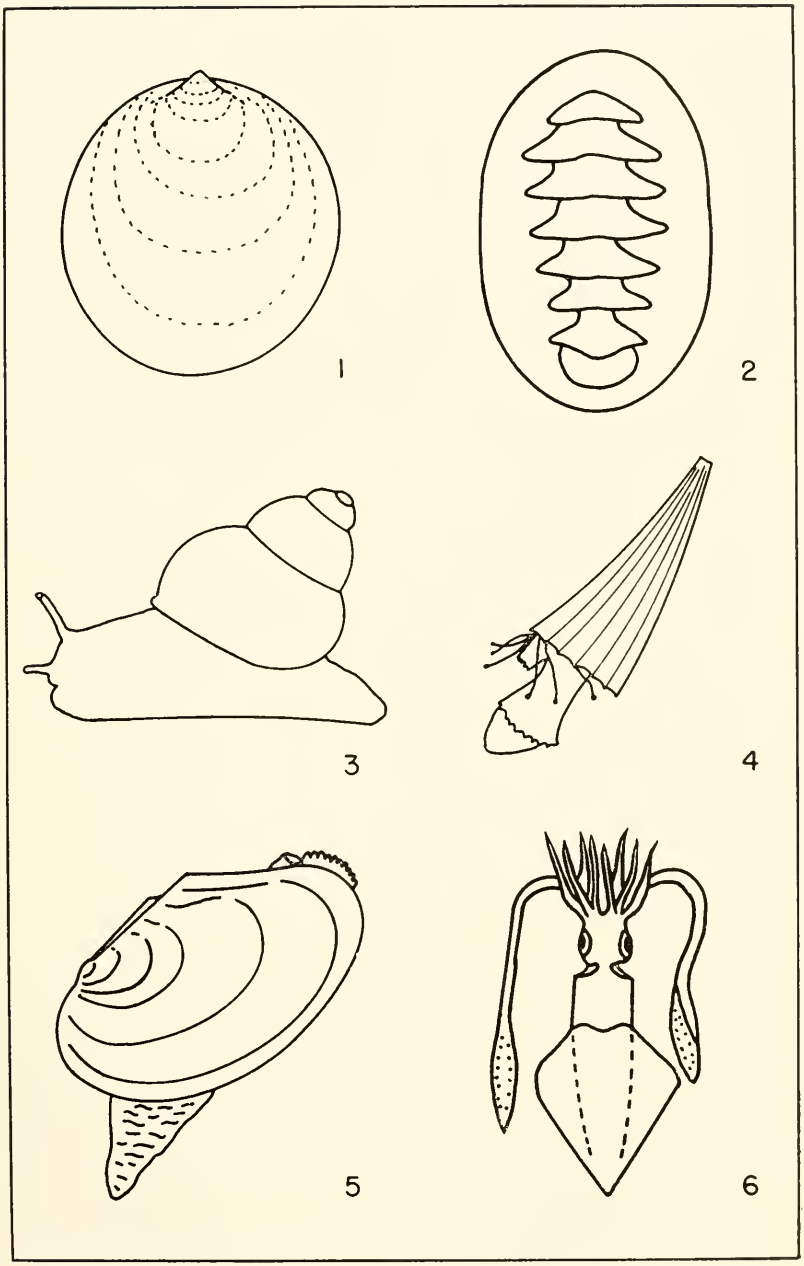
FIG. 4. Class Scaphopoda. A tusk shell (*Dentalium*) in lateral view, showing the conical foot extended, and the peculiar tentacles, called captacula. Approximately × 1.

FIG. 5. Class Pelecypoda. A mussel (*Anodonta*) in lateral view, showing extended foot, and incurrent and excurrent siphons. Approximately × ⅓.

FIG. 6. Class Cephalopoda. A squid (*Loligo*) in dorsal view. Approximately × ¼.

Figure 1 modified from Lemche, 1957; figures 2, 3, 4, 5, and 6 modified from Leonard, 1959.

PLATE 1



marine and fresh-water species and numerous families, two of which occur in Kansas: Unionidae and Sphaeriidae. The Sphaeriidae are small, thin-shelled mussels, having a simple pallial line and no hinge plate. The right valve has four lateral teeth, two anterior and two posterior to the cardinal teeth; the left valve has two lateral teeth, one anterior and one posterior to the cardinal teeth. The Sphaeriidae possess other unique characters; but, because this bulletin is not concerned with that family, its characters will not be considered in further detail.

The unionids are characterized as follows: shell nacreous having a thick epidermis; beaks usually sculptured, often showing remains of nuclear shell; ligament opisthodetic (behind beak); hinge having or lacking teeth, when teeth are present they are the pseudocardinals and laterals, but never having anterior laterals; pallial line simple.

Three subfamilies of unionids are recognized in Kansas: Unioninae, Anodontinae, and Lampsilinae. Differentiation of the subfamilies is based on characteristics listed below:

UNIONINAE lack papillae on edge of mantle; branchial opening well developed; marsupium formed by all four gills or by outer gills only; glochidia semi-elliptical or semicircular, lacking spine; hinge always complete, having rather strong teeth; generally no sexual differentiation of shell.

ANODONTINAE have branchial opening well-defined, no flaps or papillae in front of opening on edge of mantle; marsupium formed by outer gills in entire length; glochidia semicircular to triangular having hook in middle of ventral margin of each valve; hinge rarely complete and if so reduced; secondary sexual differences of shell rarely present.

LAMPSILINAE have edge of mantle in front of branchial opening smooth to crenulated or bearing papillae; marsupium rarely formed by whole outer gill, generally only by, or within, posterior part; glochidia semicircular or semielliptical, lacking spine, rarely cell-shaped and having two spines; hinge generally complete, having well-developed teeth, rarely reduced; sexual differences of shell usually noticeable, often strongly expressed.

For a more complete discussion of the characteristics of the subfamilies the reader is referred to Walker (1918).

MORPHOLOGY OF UNIONIDAE

Structure of Shell

All Unionidae secrete a bivalved shell by means of the mantle. The shell of unionids varies in shape, color, size, and thickness, but is consistently composed of three layers of secreted material. The outer layer, called the periostracum or epidermis, is a thin, horny, albuminoid material that protects the underlying portions of the shell from mechanical erosion and from dissolution by carbonic and other acids found in water. Damage to the periostracum, that is

deposited only at the edges of the mantle, results in various degrees of erosion of the underlying layers that, incidentally, is characteristic of most unionid shells found in the streams of Kansas. The color of the periostracum of Kansas species varies from black or brown to yellow or green; in addition, the periostracum may be smooth or wrinkled. The middle or prismatic layer is relatively thin and is composed of vertical prisms of calcium carbonate in the form of calcite. The inner layer, called nacre or mother-of-pearl, is the thickest layer in all but the youngest shells and is composed of thin laminae or plates of calcite, aragonite or both. The nacreous and prismatic layers may be deposited by almost any part of the mantle. Among unionids in Kansas, the nacre varies in color from white, cream, or salmon to purple or pink. A fourth layer, the hypostracum, may occur as a secretion of the adductor, retractor, and protractor muscles; chemically, the hypostracum closely resembles the nacreous layer.

The shell is divided into a right and left valve and is held together dorsally by a ligament (Plate 2, figures 2, 5). The ligament is a dark brown, proteinaceous substance; and varies in length and thickness, but in unionids the ligament functions by its elasticity and opens the two valves when the adductor muscles relax. Each shell has anterior, posterior, ventral, and dorsal margins (Plate 2, figure 1). The anterior margin of the shell can be identified by the position of the pseudocardinal teeth, which in fresh-water mussels are always situated anteriorly. The anterior and posterior margins are curved, straight, or pointed whereas the dorsal and ventral margins are straight, convex, or concave. Anterior to the ligament is the inflated umbo (Plate 2, figure 1) that in young or well preserved shells usually shows the outlines of the embryonic or nepionic shell. Extending from the posterior margin of the umbo in a general posteroventral direction and developed to varying degrees is the posterior ridge (Plate 2, figures 2, 3). Some species (Plate 2, figures 2, 3), have a lateral ridge anterior to the posterior ridge. The lateral ridge extends from the lateral area of the umbo over the lateral portion of the valve to its ventral margin.

The area anterior to the umbo is termed the anterior slope; the posterior slope (Plate 2, figures 2, 3) is posterior to the umbo. These slopes differ according to species. In some species the posterior slope is extended dorsally and forms a posterior wing (Plate 2, figure 5), and in others the anterior slope extends dorsally and forms an anterior wing (*Leptodea laevissima,* Plate 33). The anterior wing is rarely greatly developed.

MORPHOLOGICAL FEATURES OF THE UNIONID SHELL

Fig. 1. *Quadrula nodulata* Rafinesque, catalogue no. 10502; exterior, right valve. Actual length, 1¾ inches.

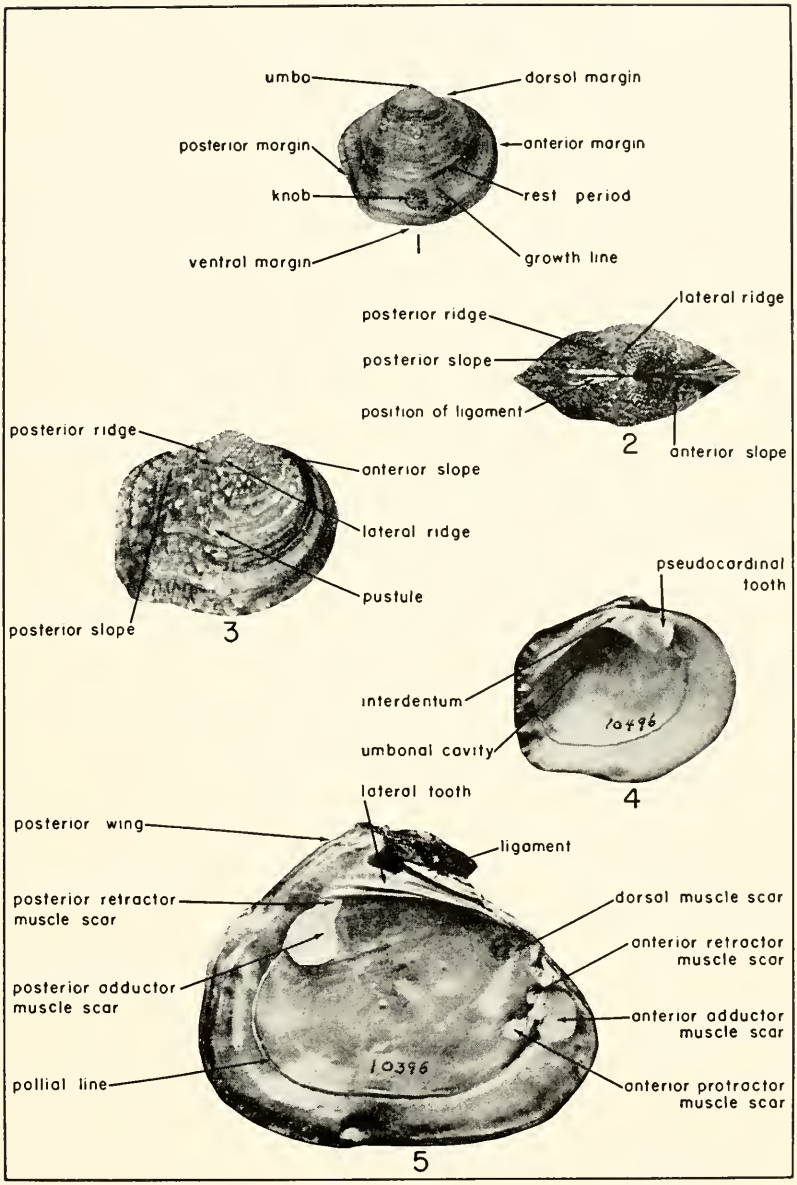
Fig. 2. *Quadrula quadrula* Rafinesque, catalogue no. 10496; dorsal aspect of shell. Actual length, 2⅜ inches.

Fig. 3. *Quadrula quadrula* Rafinesque, catalogue no. 10496; exterior, right valve. Actual length, 2⅜ inches.

Fig. 4. *Quadrula quadrula* Rafinesque, catalogue no. 10496; interior, left valve. Actual length, 2⅜ inches.

Fig. 5. *Proptera alata* (Say), catalogue no. 10396; interior, left valve. Actual length, 4½ inches.

PLATE 2


umbo
dorsal margin
posterior margin
anterior margin
knob
rest period
ventral margin
growth line
1
posterior ridge
lateral ridge
posterior slope
position of ligament
anterior slope
2
posterior ridge
anterior slope
lateral ridge
pustule
posterior slope
3
pseudocardinal tooth
interdentum
umbonal cavity
10496
4
lateral tooth
posterior wing
ligament
posterior retractor muscle scar
dorsal muscle scar
anterior retractor muscle scar
posterior adductor muscle scar
anterior adductor muscle scar
pollial line
10396
anterior protractor muscle scar
5

The exterior of the valve is smooth (*Ligumia subrostrata,* Plate 39, figure 3), marked by undulations (*Crenodonta peruviana peruviana,* Plate 7, figures 3, 4), set with pustules (*Quadrula quadrula,* Plate 2, figure 3), or knobs (*Quadrula nodulata,* Plate 2, figure 1), or roughened by growth lines (*Proptera capax,* Plate 36, figure 3).

Internally the hinge line of most unionid shells is provided with hinge teeth, referred to as pseudocardinal and lateral teeth (Plate 2, figures 4, 5). These teeth are interlocking, elevated structures holding the two valves in position when open and preventing the valves from shearing apart when closed. The pseudocardinal tooth of one valve fits into a corresponding depression in the hinge of the opposing valve. Although variable in size, shape, thickness, and ornamentation, the pseudocardinals are always situated anterior to the lateral teeth and usually anterior to or directly below the umbo. The number of pseudocardinals varies from one to two in either the left or right valves. Accessory denticles may appear anterior and posterior to the main teeth, but are of little taxonomic significance. The pseudocardinal teeth vary from compressed, thin, and sharp to thick, wide, and heavily serrated. The lateral teeth are situated posterior to the umbo and posterior to the pseudocardinals, and are high or low, straight or curved, serrated or smooth, long or short. There are usually two lateral teeth in the left valve and one in the right valve. Frequently an accessory lateral tooth develops ventral to the main lateral tooth in the right valve. On many kinds of fresh-water mussel shells, such as those of *Quadrula quadrula,* there is an area between the lateral and the pseudocardinal teeth referred to as the hinge plate or interdentum (Plate 2, figure 4). The length of the interdentum is more or less parallel with the anteroposterior axis of the shell, and its width is approximately parallel with the dorsoventral axis of the shell. The interdentum is absent in some species (*Proptera alata,* Plate 2, figure 5) and weak in others (*Truncilla truncata,* Plate 29, figures 1, 2).

Both the pseudocardinals and laterals can be absent (*Anodonta grandis,* Plate 20) or reduced (*Strophitus rugosus,* Plate 15). In one genus (*Lasmigona,* Plates 20, 21) the lateral teeth are absent, and the pseudocardinal teeth are massive.

The umbonal cavity (Plate 2, figure 4) extends into the umbo, but in some species (*Elliptio dilatatus,* Plate 18) the umbonal cavity is shallow or nearly wanting.

The inside of the shell has in addition to features already discussed, at least seven scars or cicatrices produced by attachment of

muscles. The position, size, and depth of each muscle scar is useful in the identification of the various species. The largest scars on the shell are the anterior and posterior adductor muscle scars (Plate 2, figure 5). A posterior retractor muscle scar is situated dorsal to the posterior adductor muscle scar, and an interior retractor muscle scar is situated slightly dorsal and posterior to the anterior adductor muscle scar (Plate 2, figure 5). These may, however, fuse with or be incorporated into the adductor muscle scars and be difficult to distinguish. Posterior to the anterior adductor muscle scar there is a single scar known as the anterior protractor muscle scar (Plate 2, figure 5). An impression near the ventral edge of the shell, and extending from the anterior adductor muscle scar to the posterior adductor muscle scar, marks the point of attachment of the mantle to the shell and is referred to as the pallial line (Plate 2, figure 5). It is typically deeply impressed anteriorly and lightly impressed posteriorly. Within the cavity of the umbo there is typically a series of scars for the attachment of the dorsal muscles from the mantle to the shell (Plate 2, figure 5). The dorsal muscle scars may be difficult to see, as in *Actinonaias carinata carinata* (Plate 28), or easily seen, as in *Leptodea* (Plates 22, 23). The function of the muscles is discussed beyond under the account of the soft anatomy.

Soft Anatomy

Muscles of shell (Plate 3, figure 3)

The anterior and posterior adductor muscles close the valves and maintain their closure; if one or both of these muscles are cut the valves will open. The fibers of the adductor muscles extend from one valve directly across to the other; they have no direct connections to the body of the animal.

The anterior and posterior retractor muscles insert on the shell and their fibers extend into the foot and body of the animal. These muscles retract the foot into the shell.

Extension of the foot is accomplished with the aid of the anterior protractor muscle, most of the fibers of which extend over the viscera.

Retraction of the mantle is accomplished by the pallial muscles at the margin of the shell and by the dorsal muscles in the umbonal cavity (Plate 2, figure 5).

Mantle

The mantle or pallium (Plate 3, figure 1) secretes the shell, aids in respiration, serves as a sense organ, and aids in feeding. The mantle, which is open ventrally, anteriorly and posteriorly, but is closed dorsally, forms two lobes overlying the animal and immediately within the shell. The posterior portion of the mantle forms the excurrent and incurrent siphons (Plate 3, figure 1) for the intake and exit of water. There are numerous blood vessels (Plate 4, figure 2) in the mantle and some exchange of gases occurs there. In addition, the epidermis of the mantle is ciliated and aids in feeding by trapping food in

MORPHOLOGICAL FEATURES OF THE SOFT ANATOMY OF A UNIONID MUSSEL

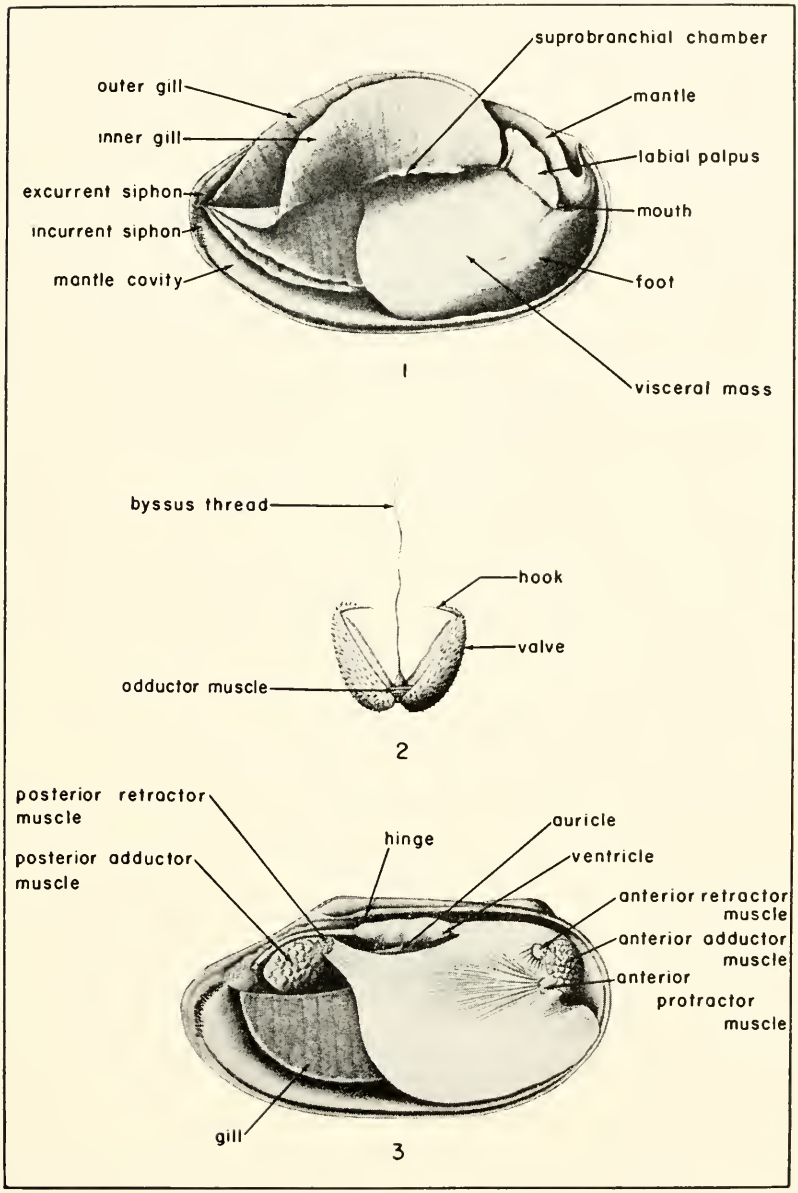
Fig. 1. Right valve and mantle removed exposing gills, foot, labial palpi, and incurrent and excurrent siphons. Length, approximately 5 inches.

Fig. 2. Glochidium just before leaving the gills. Enlarged approximately × 20.

Fig. 3. Right valve, mantle, and gills removed. Length, approx. 5 inches.

Figures 1, 2, and 3, *Anodonta fluviatilis* (Dillwyn) (= *Anodonta cataracta* Say) modified from Simpson, 1884 (pls. 4, 7, and 8)—courtesy of New York State Museum and Science Service.

PLATE 3


suprobranchial chamber
outer gill
mantle
inner gill
labial palpus
excurrent siphon
mouth
incurrent siphon
mantle cavity
foot
visceral mass
1
byssus thread
hook
valve
odductor muscle
2
posterior retractor muscle
auricle
hinge
posterior adductor muscle
ventricle
anterior retractor muscle
anterior adductor muscle
anterior protractor muscle
gill
3

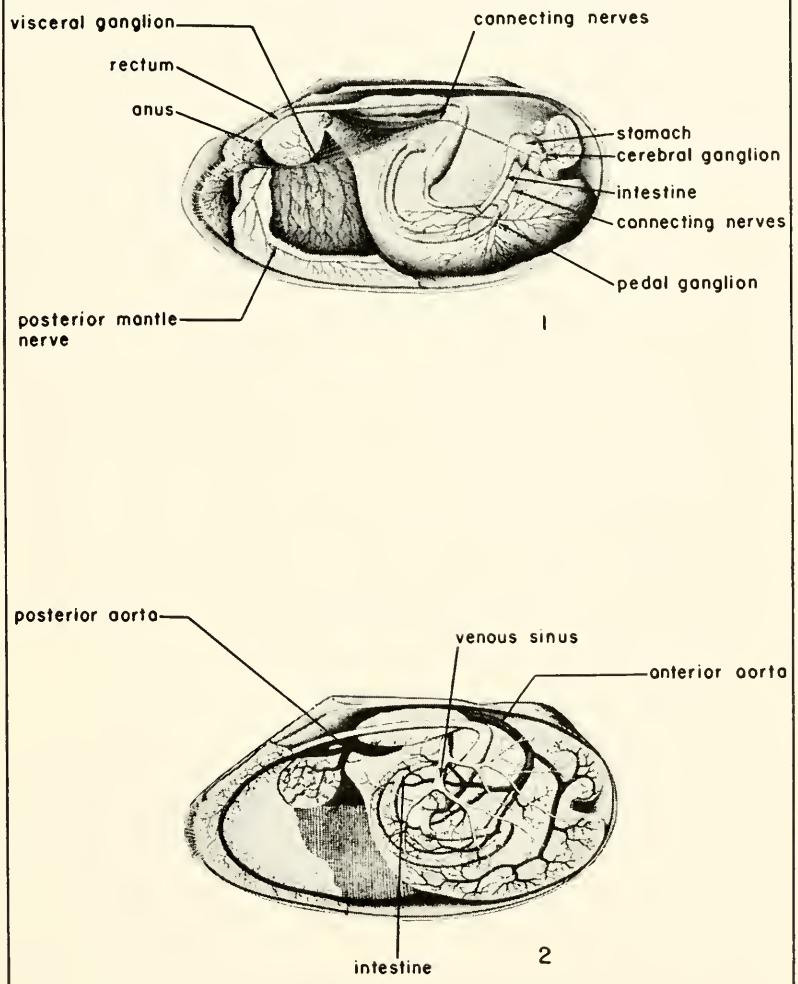
MORPHOLOGICAL FEATURES OF THE SOFT ANATOMY OF A UNIONID MUSSEL

Fig. 1. Right valve removed showing the nervous and digestive systems. Length, approximately 5 inches.

Fig. 2. Right valve removed showing circulatory and digestive systems. Length, approximately 5 inches.

Figures 1 and 2, *Anodonta fluviatilis* (Dillwyn) (= *Anodonta cataracta* Say) modified from Simpson, 1884 (pls. 9 and 10)—Courtesy of New York State Museum and Science Service.

PLATE 4


visceral ganglion
rectum
anus
connecting nerves
stomach
cerebral ganglion
intestine
connecting nerves
pedal ganglion
posterior mantle nerve
1
posterior aorta
venous sinus
anterior aorta
intestine
2

mucous and transporting the "mucous string" to the area of the labial palpi. The space between the mantle and the body of the animal is the mantle cavity (Plate 3, figure 1).

Gills

There is a pair of gills on either side of the foot; the gills next to the foot are the inner gills and those next to the mantle are the outer gills (Plate 3, figure 1). The gills serve as organs of respiration, aid in feeding, and are used in reproduction. Water brought into the mantle cavity *via* the incurrent siphon enters the ostia of the gills by the action of cilia and passes into water tubes in the gills. Traveling dorsally and anteriorly in the tubes, the water eventually passes into the suprabranchial chamber (Plate 3, figure 1), and moves posteriorly to the excurrent siphon. As water passes over the gills gaseous exchanges occur and particulate food matter is trapped by mucous secreted from the gills. The food is trapped on all areas of the gills, but is concentrated ventrally by the cilia of the gills in a ventral food groove whence it is transferred anteriorly to the labial palpi (Plate 3, figure 1). At the anterior end, food is sorted from inorganic debris and passed on to the mouth by the elongate labial palpi.

The unionids are unique among pelecypods in that they use all or some part of the gills as a marsupium for the developing eggs and glochidia, until they are discharged from the parent.

Foot

The class name Pelecypoda, or hatchet foot, indicates the shape of the foot (Plate 3, figure 1). The highly muscular foot is extended between the two valves and pushed into the substrate; therefore it serves as a holdfast organ but is primarily concerned with locomotion.

Locomotion is accomplished in the following manner: with the aid of the anterior protractor muscles and blood sinuses of the foot, the foot is extended from between the two valves and inserted firmly into the substrate in the anteroventral direction. The animal contracts the retractor muscles, the muscles of the foot, and pulls itself forward. Locomotion of the unionid is slow and erratic.

Digestive System

The digestive system of the unionid is highly adapted for use of particulate matter, such as unicellular algae. Mouth, esophagus, digestive gland, intestine, rectum, and anus are present. The mouth (Plate 3, figure 1) lacks masticatory structures, and the esophagus merely passes food on to the stomach. Digestion is accomplished in the stomach (Plate 4, figure 1) with the aid of digestive juices from the digestive gland, which surrounds the stomach, and the crystalline style, which is specific in the digestion of carbohydrates. The crystalline style is an elongate, rodlike structure within a style sac, a diverticulum of the stomach. The intestine (Plate 4, figure 1) extends from the stomach into the foot, makes several loops, and eventually passes dorsally where it is surrounded by the heart. Posterior to the heart the intestine enlarges and forms a rectum (Plate 4, figure 1), which empties *via* the anus (Plate 4, figure 1) into the area near the excurrent siphon, where the waste materials are swept out of the mantle cavity and away from the animal. The part of the animal occupied by the digestive system, digestive glands, and gonads is referred to as the visceral mass (Plate 3, figure 1).

Kidney

Although physiologically the kidneys of all animals perform the same general function, that is to say, they are homeostatic organs, the kidney of the unionid is unique in its morphology and relationship to the heart. The kidney is situated immediately below the heart, and one end of the kidney opens into the pericardial chamber of the heart. Pericardial fluid, therefore, is filtered through the kidney and nitrogenous wastes and salts are removed or retained in the ventral glandular part of the kidney as is necessary for the internal stability of the animal. The nitrogenous wastes are eventually discharged from the more dorsally situated bladderlike structure of the kidney into the suprabranchial chamber of the gills and passed out the excurrent siphon.

Circulatory System

The circulatory system consists of a heart composed of a single ventricle (Plate 3, figure 3), two auricles (Plate 3, figure 3) surrounded by a pericardial cavity, and numerous arteries and veins (Plate 4, figure 2). The almost transparent blood passes from the two auricles to the ventricle then out the anterior and posterior aortae (Plate 4, figure 2). The blood eventually reaches smaller vessels, which ramify over the body. Blood passing to the mantle is oxygenated and returned directly to the heart. Blood from the other parts of the body collects in a venous sinus (Plate 4, figure 2) and passes through the kidney, then is moved through the gills where it is oxygenated and is eventually returned to the auricles of the heart.

The blood of the fresh-water mussels is an almost transparent, opalescent fluid, having no corpuscles for carrying oxygen as in the vertebrates. There are, nevertheless, small numbers of amoebocytes in the blood (Dundee, 1953). The specific gravity of the blood is variable depending on the species, but averages approximately 1.0026 (Ellis, Merrick, and Ellis, 1930).

Nervous System (Plate 4, figure 1)

Two cerebral ganglia near the mouth on each side of the esophagus send connectives (long nerves) into the foot to the two pedal ganglia, and posteriorly to the two visceral ganglia. Small nerves extend from these ganglia into the tissues. There are no ears or eyes in the sense of vertebrate structures; there is an otocyst for balance, and various areas of the edge of the mantle are sensitive to light. Chemotactic sense receptors around the labial palpi and the mouth detect food.

Reproductive System

Fresh-water mussels are typically dioecious; that is to say, the organs of the male and female are in separate animals. *Anodonta imbecilis* has been reported as monoecious. The reproductive organs lie in a mass of tissue above the foot and their materials are discharged into the suprabranchial chambers of the gills. Sperm of the male pass to the outside, but eggs are discharged into the water tubes of the gills of the female where sperm fertilize the eggs and further development occurs.

For a more thorough treatment of the soft anatomy of fresh-water mussels the reader is referred to Simpson (1884), Baker (1928), and Borradaile *et al.* (1958).

DEVELOPMENT AND GROWTH OF FRESH-WATER MUSSELS

Development

The development of the fresh-water mussel consists of five distinct stages: 1) fertilized egg; 2) glochidium in the gill of the mussel; 3) parasitic stage on a fish or a salamander; 4) free-living juvenal stage; and 5) adult stage.

Eggs are fertilized by sperm that enter the gills with incurrent water and develop into small larvae called glochidia (Plate 3, figure 2). Glochidia range from ⅛ to ⅔ of a millimeter in height and from ¼ to ⅔ of a millimeter in length. They are typically rounded or oval and possess rudiments of a mouth, heart, foot, and intestines when discharged from the parent. The two valves, hinged dorsally, are held together by an adductor muscle (Plate 3, figure 2). There is usually an accessory sensory structure, the byssus thread (Plate 3, figure 2), which probably aids in the detection of a host fish. Some genera (*Anodonta, Strophitus,* and *Lasmigona*) have hook-type glochidia. The hook is at the ventral margin of the glochidial shell and is used to assure attachment of the glochidium to the fish. Hook-type glochidia are most frequently found on the fins and tail of the host fish. Hookless glochidia are most frequently found on the gills. Members of the genera *Fusconaia, Crenodonta, Quadrula, Pleurobema,* and *Elliptio* have this type of glochidium. A third type of glochidium, the axe-headed type related to the hook-type, is restricted to the genus *Proptera.*

Upon discharge from the parent the glochidia attach to, and embed in, the tissues of the proper fish host where further development occurs. During that parasitic stage, the glochidium completes the adult structures, but does not increase noticeably in size. The period of time that the larva is embedded in the host depends on the viability of the host, temperature of the water, and the place of attachment to the host. The fact that *Aplodinotus grunniens* (freshwater drum) and *Ictalurus punctatus* (channel catfish) are infected by several different kinds of glochidia probably is correlated with the bottom feeding habits of these fishes. In nature most infections are light, but heavy or massive infections may be induced artifically. The transformed glochidium breaks through the skin of the fish and falls to the stream bottom as a juvenal mussel. The adult shell forms under the glochidial shell, and the animal begins its growth to adulthood.

Some glochidia of *Strophitus edentulus, Anodonta imbecilis,* and

Obliquaria reflexa are known to develop without passing through the parasitic stage; it is thought, however, that other glochidia of those three genera pass through the parasitic phase. In the non-parasitic cycle the young are retained in the gills of the parent until mature, and discharged into the water where they subsequently fall to the stream bottom to become adults.

Growth

Increase in size of the shell is accomplished by secretions of the mantle at the margins of the valve. Increase in thickness of the valve is the result of secretions of all areas of the mantle. The periostracum of epidermis of the mussel shell typically shows dark, thin lines alternating with light, broader areas on the shell. The thin, dark lines are spoken of as "rest periods" or lines of arrested growth (Plate 2, figure 1). Less prominent lines of temporary arrested growth are called "growth lines" (Plate 2, figure 1). In some mussels a reliable way to estimate the age of the shell is to count the "rest periods," because these lines roughly correspond to the end of one year's growth. This is not necessarily true, because fluctuations in water level, pollution of water at various intervals, scarcity of food, and other adverse conditions may bring about a period of arrested growth. Growth of fresh-water mussels has been discussed by Lefevre and Curtis (1912); Isley (1914); and Coker, Shira, Clark, and Howard (1921).

ECOLOGY OF FRESH-WATER MUSSELS

Mussels spend the entire juvenal and adult life partially or wholly buried in mud, sandy mud, or mud and rock bottoms of streams, ponds, lakes, canals, and swamps—any permanent body of water. Mussels are rarely found in stream bottoms of shifting sand. An animal generally orientates so that the posterior portion of the shell protrudes from the substrate and is directed upstream. In this way, materials brought in by the ventral incurrent siphon are in part forced into the mantle cavity by the force of the water current, and waste products that are eliminated from the dorsal excurrent siphon are quickly swept away from the animal.

In Kansas there are two primary habitats for fresh-water mussels, impounded water (artificial lakes and ponds) and natural streams. The ecology of lakes, ponds, and streams in Kansas is poorly known. Permanent bodies of water in Kansas, even though artificial, undoubtedly support large unionid populations. A one and one-half acre pond on the campus of The University of Kansas yielded

approximately 2,178 *living* unionids representing four different species *Anodonta grandis, Crenodonta peruviana costata, Ligumia subrostrata*, and *Uniomerus tetralasmus* (Murray, 1960).

Although fresh-water mussels in Kansas have a high tolerance to siltation, they are not tolerant to industrial pollution. Early records indicate that many streams in Kansas had relatively clear water; with the advent of agriculture and industry, both turbidity and industrial pollution have greatly increased. Although there is evidence that only three species have been extirpated from the state, the abundance of various species has been seriously affected. In areas where Scammon (1906) reported species as common or abundant, they are now rare, such as *Actinonaias carinata carinata, Ligumia recta latissima* and *Plagiola lineolata*, to mention but a few.

In certain areas of the Mississippi Valley many species were harvested to near extinction, and many beds were greatly depleted. Some harvesting occurred in streams in Kansas in the early 1900's, but not to the extent that any species were extirpated. Because the economic value of fresh-water mussels has declined in recent years, overharvesting does not appear to be likely in the near future.

Continued industrial pollution and increased turbidity of the waters of Kansas are more likely to extirpate unionids, as well as other aquatic animals. Therefore, as well as for other reasons, Kansas should take the measures that are necessary to reduce and check soil erosion and to control industrial wastes by keeping them out of streams and by purifying those that do enter streams.

Condition of Water

The chemical and biological condition of the water greatly influences the kinds and number of mussels present. Turbidity is probably the most important single negative factor and can result from either biological or physical conditions of the water. Biological turbidity generally benefits mussels because this is particulate food matter (plankton) in suspension, and mussels are dependent upon this for food. Turbidity resulting from mud and sand is generally detrimental to mussels, directly by clogging the feeding and respiratory mechanisms or indirectly by reducing the amount of food in the water. Turbidity of streams in Kansas measured from three to fifteen inches on a Secchi disk in July and August, 1956-1959.

The amount of calcium carbonate available to the mussel and the amount of carbon dioxide (CO_2) and oxygen (O_2) dissolved in the water are of primary importance. Other elements and

compounds in solution are surely important but are of less obvious significance. Because calcium carbonate is necessary for the formation of the molluscan shell, a low calcium carbonate content in the water brings about a population of thin-shelled mussels. A high CO_2 content in the water causes the formation of excessive amounts of carbonic acid, that in turn dissolves the calcium carbonate deposited in the mussel shell. During drought years, when pondlike areas of a stream become stagnant, the lack of oxygen and the increase of carbon dioxide threaten mussel life in the stream.

Bottom Conditions

Although important to certain species, the type of stream bottom can vary considerably--within the limits of tolerance for any given species. Members of the genus *Anodonta* and *Leptodea fragilis* are often found in soft to hard mud, rarely in rocky areas. Members of the genera *Crenodonta*, *Tritogonia*, and *Quadrula* are to be expected in rocky and gravelly areas as well as in mud bottoms. The most highly restrictive ecological factor for fresh-water mussels is the shifting sand bottom. Because most streams of western and central Kansas have this type of bottom, few species of mussels exist in these streams, except as isolated populations in suitable areas.

Depth of Water

The depth of water inhabited by mussels depends upon temperature, the presence of the proper amounts of dissolved oxygen, and suspended food material. In fast flowing streams mussels are found at depths of 15 feet or more. In Kansas, mussels are frequently found in shallow water (2 to 4 feet) during the summer and early autumn, but as the water cools in late autumn, there is a general movement to deeper pools in the stream. The depth at which mussels live in ponds varies with the time of the year, temperature of the water, presence of a thermocline, and dissolved gases present at various depths; in Kansas, this depth probably varies from 1 to 10 feet. Of the Kansas unionids, only *Megalonaias gigantea* remains in relatively deep water (5 feet or more) during even the warmer months. Some species, *Carunculina parva* and *Lampsilis subrostrata* may be found in pondlike areas of a stream deep enough to cover only the siphons, at most an inch in depth. The water in these areas may be as warm as 40° to 45° C.

Vegetation

Because plants covering the water cut the light incidence in the water and in turn lower the amount of plankton present at various depths, few mussels are found in heavily covered ponds. Because plant-cover in Kansas streams typically occurs only briefly during drought, the problem is not important for stream faunas.

Light

Although the matter has been poorly studied, it is evident that mussels react to variations in light intensity. On cloudy days they are less active and siphon water at a much slower rate than on bright sunny days. Mussels quickly close the shell if the light rays are suddenly interrupted, as by a shadow passing over the animal.

Current

The mixing action of moving water aids in the even distribution of dissolved gases, food, and minerals necessary to the mussel. In well mixed water, mussels tend to move into greater depths, and conversely into shallower water as the stream becomes quiet. Mussels react similarly in ponds and lakes as the water is circulated by the wind.

Temperature

Water maintains a fairly constant temperature in contrast to the air. The warmest temperature of a stream bottom recorded in this study was a temperature of 38° C. on the Delaware River, July 28, 1956. During the summer months and early autumn the bottom temperature of Kansas streams varies from 25° to 29° C., at least in areas where mussels are found. Winter temperatures on or near the bottom of Kansas streams vary from 5° to 20° C.

Predation and Parasitism

Mink, otter, raccoon, muskrat, fish, and some birds are reported as predators of mussels (Baker, 1928, p. 29). In Kansas, Stains (1956) reported that the following unionids were commonly eaten by raccoons: *Crenodonta peruviana costata, Quadrula quadrula, Q. pustulosa, Lampsilis anodontoides anodontoides, Ligumia subrostrata, Lasmigona complanata, Tritogonia verrucosa, Anodonta grandis,* and *Proptera alata.* It is not uncommon to find small piles of broken shells near or around a muskrat burrow, or on a small

boulder near the stream. These piles usually are 10 to 20 feet from a muskrat burrow, but in several instances shells have been found up to and slightly inside the under-water entrance of the muskrat burrow. The most common species occurring in these small heaps of shells are: *Anodonta grandis, Leptodea fragilis, Lampsilis anodontoides* (young), *Lasmigona complanata* (young), and *Uniomerus tetralasmus.* These are the most common thin-shelled species in the streams of Kansas. Baker (1918) lists several species of *Lampsilis* and *Anodonta* as fish food, as well as numerous species of sphaeriids. In Kansas, muskrats undoubtedly take the heaviest toll of adult mussels, and certain fishes take the heaviest toll of juvenal mussels.

Aboriginal man used the meat of mussels for food, and the shells for tools and ornaments. Specimens recently identified in the collection of the Kansas Historical Society indicate that pre-Columbian Indians used *Lampsilis ovata* and *Elliptio dilatatus,* as well as other species, for food. European man has not acquired a taste for the meat of fresh-water mussels, but he has used the shells for buttons, and the meat as food for chickens and hogs.

Three species of water mites are known to parasitize mussels in Kansas, *Unionicola crassipes, U. wolcotti,* and *U. formosa* (Murray, unpublished data). The eggs and larvae are generally embedded in the gills, foot, and mantle, and the adults move around over the gills and body. In most instances they seem to cause little damage to the mussel.

Several species of flukes parasitize mussels but have not been studied in the Kansas fauna. Baker (1928, p. 30) and Utterback (1916b, p. 520) report several species of flukes commonly found in the branchial and pericardial cavities, various muscular areas of the body, and in the ovaries. Discoloration of the nacre of *Anodonta sp.* is frequently the result of the presence of distomid flukes or larval mites.

COLLECTION AND PRESERVATION OF MUSSELS

Numerous methods have been devised for obtaining fresh-water mussels. The most successful method used in the tributaries of the Ohio and Mississippi rivers was a technique popular in the early 20th century, the bar and crowfoot hook method. Hooks composed of four prongs were suspended from 2 to 5 feet on a bar 6 to 10 feet long. These hooks were separated from each other by 4 to 6 inches. As the hooks were dragged along the bottom of the stream,

one prong of a hook might fall into the open valves of a mussel. When this happened the hook stimulated the mussel to close the valves, and the mussel could be pulled to the surface. Among other techniques used in the early 1900's were the dip-net drag, shoulder rake, shell tongs, fork, and the dredge. Each of these was advantageous in particular situations depending on depth of water, bottom conditions, and the number of persons operating the equipment. A detailed account of the various techniques used is given by Lefevre and Curtis (1912).

One of our most effective methods was the hand method. By feeling along the stream bottom with the bare hands and placing the mussels in a sack or nearby boat, we could effectively sample and collect from an area. Shells of dead mussels are to be found along the stream banks but these shells are frequently worn, and much of the original luster and beauty are lost. Smaller specimens can be recovered by straining bottom-mud and water through a screen of ¼ inch mesh.

In most years, the best time to collect mussels in Kansas is late summer or early autumn, inasmuch as 1) the streams then are usually lowest, allowing greatest accessibility to beds of mussels, and 2) most fresh-water mussels in Kansas reproduce at those times of year; consequently, the mussels move into shallower water and can be more easily obtained.

The entire animal can be preserved in 10 per cent formalin or preferably in 70 per cent ethyl alcohol. In either case the animal must be washed several times in water and alcohol in order to remove the copious amounts of mucous. Most collectors save only the shell. By placing the live animal in boiling water or a steam oven, the adductor muscles can be relaxed to permit removal of the soft parts.

Dead shells that are obtained from stream banks may frequently be restored to their original luster by soaking in a mild acid, such as oxalic acid, followed by light scrubbing with a wire brush.

In our work, at the time of collection the collector records facts concerning water temperature, bottom temperature, stream velocity, surrounding bank conditions, time spent collecting, time of day, date, and other important ecological information in a field notebook. The collector provides a label for the specimens taken at a particular locality. He writes on this label the date, locality, collector's name, and field number, corresponding to the information in the collector's field notes. Once the specimens are properly identified

a permanent label is placed in the container holding the specimens. All the data appearing on the field tag are transferred to this label as neatly as possible. Regardless of the size of the collection, a catalogue should be kept. This should be a book of good quality paper in which a catalogue number, name of shell (genus, species, authority), date, and collector's field number are recorded. The catalogue number is placed on the shell and on the permanent label accompanying the shell. The catalogue, specimens, and field notes should not be altered or destroyed. The same species from a different locality or from the same locality but obtained at a later date receives a different catalogue number.

KEY FOR IDENTIFICATION OF SPECIES AND SUBSPECIES OF MUSSELS IN KANSAS

Introduction

The key is intended to aid in the identification of species and subspecies occurring in Kansas. The key should be used in conjunction with the descriptions of the several species and the plates accompanying each species.

The key is arranged in couplets. Each statement of a couplet is in opposition to the other or at least distinctly different. It is necessary to read each statement within a couplet before making a choice. The choice may refer the reader to another couplet or to the name of a species; the page number following the name of a species refers the reader to the account of that species. If any part of the statement of the couplet does not seem to be true for a specimen, the other statement of the couplet should be true.

1. A. Surface of shell having knobs, pustules, or undulations 2
   B. Surface of shell lacking knobs, pustules or undulations (only growth lines interrupt smoothness of shell) 16
2. A. Surface of shell having undulations, lacking knobs or pustules 3
   B. Surface of shell having or lacking undulations, having knobs, pustules or irregular W-shaped sculpture 7
3. A. Shell alate, highly compressed ..... *Lasmigona complanata* p. 87
   B. Shell not alate, not highly compressed 4
4. A. Undulations only on dorsoposterior slope never on lateral or posteroventral portions of shell ..... *Lasmigona costata* p. 86
   B. Undulations on dorsoposterior slope and on most of shell except anterior end 5
5. A. Shell longer than 165 mm. ..... *Megalonaias gigantea* p. 42
   B. Shell shorter than 165 mm. 6

6. A. Shell compressed; shell having numerous small undulations over surface; umbo flat, not extending greatly above hinge line ..... *Crenodonta peruviana costata* p. 49
   B. Shell inflated; shell having few large undulations over the surface; umbo inflated, extending well above hinge line. *Crenodonta peruviana peruviana* p. 47
7. A. Shell lacking distinct lateral teeth ..... *Arcidens confragosus* p. 97
   B. Shell having distinct lateral teeth 8
8. A. Umbonal region having small zigzag undulations, some forming irregular W's; lacking distinct pustules or knobs. *Megalonaias gigantea* p. 42
   B. Umbonal region lacking small zigzag undulations, may have pustules or knobs 9
9. A. Length and height of shell nearly equal, shell quadrate, never elongate; posterior margin of shell perpendicular to dorsal and ventral margins 10
   B. Length of shell more than height, shell elongate, never quadrate; posterior margin of shell usually not perpendicular to dorsal and ventral margins, if nearly perpendicular then height of shell less than 50% of total length of shell 14
10. A. Has 2-6 knobs extending over lateral portion of shell or on posterior ridge; usually lacking pustules; if pustules present shell having deep sinus above posterior ridge 11
    B. May have knobs on shell; always having small pustules on shell; shell lacking sinus above posterior ridge 13
11. A. Knobs on posterior ridge of shell; posterior ridge high, having deep sinus above; epidermis sometimes marked by dark green chevrons ..... *Quadrula metanevra* p. 61
    B. Knobs on lateral areas of shell; posterior ridge not greatly enlarged, lacking sinus above; epidermis lacking dark green chevrons 12
12. A. Knobs on left valve opposite those on right valve. *Quadrula nodulata* p. 58
    B. Knobs on left valve not opposite (alternating with) those on right valve ..... *Obliquaria reflexa* p. 103
13. A. Pustules restricted to lateral portion of shell, remainder of shell smooth; shell inflated ..... *Quadrula pustulosa* p. 55
    B. Pustules frequently covering entire shell, restricted to posterior and lateral ridges, or any variation of the above, never restricted to lateral area; shell somewhat compressed ..... *Quadrula quadrula* p. 50
14. A. No knobs on shell; small pustules usually over most of shell, except extreme anterior end; epidermis usually dark brown or black ..... *Tritogonia verrucosa* p. 67
    B. Knobs or pustules restricted to posterior or lateral ridges of shell or both; epidermis yellow, yellowish-green or light brown 15

15. A. Lateral and posterior ridges prominent; epidermis lacking dark green chevrons ..... *Plethobasus cyphyus* p. 68
    B. No lateral ridge, posterior ridge evident and represented by knobs extending to posteroventral margin; epidermis usually marked by dark green chevrons. *Quadrula cylindrica* p. 64
16. A. Pseudocardinal teeth absent or as nodulose swellings; lateral teeth absent 17
    B. Pseudocardinal teeth present; lateral teeth usually present, if absent pseudocardinal teeth massive 19
17. A. Pseudocardinal teeth seemingly absent, but represented by small nodulous thickenings on hinge line. *Strophitus rugosus* p. 99
    B. Pseudocardinal teeth absent, no indications of their presence 18
18. A. Umbo not raised above hinge line ..... *Anodonta imbecilis* p. 95
    B. Umbo raised above hinge line ..... *Anodonta grandis* p. 92
19. A. Lateral teeth absent or as small swellings, but swellings of right valve do not interlock into swellings of left valve. *Lasmigona complanata* p. 87
    B. Lateral teeth present, lateral tooth of right valve interlocks into lateral teeth of left valve 20
20. A. Interdentum extremely narrow or offering no bearing surface to opposing valve 21
    B. Interdentum wide, may be long or short, offering obvious bearing surface to opposing valve 36
21. A. Nacre purple, pink, or salmon, if pink or salmon pseudocardinal teeth thin, highly compressed, and sharp, slightly ragged 22
    B. Nacre white, rarely pink, if pink pseudocardinal teeth thick, heavy, blunt, and extremely ragged 26
22. A. Pseudocardinal teeth thin, weak, not ragged 23
    B. Pseudocardinal teeth thick, strong, slightly ragged 24
23. A. Epidermis entirely or partially glossy, usually yellowish-green; pseudocardinal teeth sharp in young and old specimens ..... *Leptodea laevissima* p. 123
    B. Epidermis dull, yellowish to yellowish-brown; pseudocardinal teeth sharp only in young individuals ..... *Leptodea fragilis* p. 120
24. A. Umbo cavity shallow, no more than one-third of the row of dorsal muscle scars situated within umbonal cavity. *Proptera alata* p. 126
    B. Umbo cavity deep, more than one-third of the row of dorsal muscle scars situated within the umbonal cavity 25
25. A. Shell inflated, but not globose; dorsoposterior area having two to three indistinct ridges extending from umbo to posterior margin ..... *Proptera purpurata* p. 129
    B. Shell extremely globose; dorsoposterior area usually lacking indistinct ridges ..... *Proptera capax* p. 132
26. A. Shell elongate, never truncate posteriorly 27
    B. Shell globose or truncate posteriorly 33

27. A. Umbo sculpture of 5-6 concentric loops curved sharply upward posteriorly 28
    B. Umbo sculpture eroded or obsolete, if present of V-shaped or doubly looped parallel ridges 29
28. A. Adult shell never longer than 45 mm.; surface of shell smooth, growth lines not raised but marked by indistinct change of color ..... *Carunculina parva* p. 135
    B. Adult shell longer than 45 mm.; surface of shell not smooth, growth lines raised and roughened, and usually marked by distinct change of color ..... *Uniomerus tetralasmus* p. 83
29. A. Epidermis yellowish, yellowish-green, or yellowish-tan, usually glossy; nacre white to salmon, never purple; posterior end pointed 30
    B. Epidermis light to dark brown, black, or yellowish-brown, usually dull; if yellowish-brown then posterior end rounded; nacre white, rarely pink 31
30. A. Epidermis having green rays. *Lampsilis anodontoides fallaciosa* p. 146
    B. Epidermis lacking green rays. *Lampsilis anodontoides anodontoides* p. 143
31. A. Pallial line lightly impressed anteriorly, rarely forming crenulations; umbo of adult and young shell having distinct V-shaped parallel ridges ..... *Ligumia subrostrata* p. 140
    B. Pallial line deeply impressed anteriorly, usually forming crenulations; umbo of adult usually eroded, young shell rarely having indistinct V-shaped ridges 32
32. A. Posterior end of shell pointed; height of shell less than 50% of total length of shell; epidermis usually dark. *Ligumia recta latissima* p. 137
    B. Posterior end of shell rounded; height of shell at least 50% of total length of shell; epidermis usually straw-colored or yellowish-brown ..... *Lampsilis radiata siliquoidea* p. 149
33. A. Posterior ridge rounded; shell globose. *Lampsilis ovata ventricosa* p. 152
    B. Posterior ridge angulate; shell truncate posteriorly 34
34. A. Epidermis having rays broken into squarish, triangular, or chevron shaped spots ..... *Dysnomia triquetra* p. 155
    B. Epidermis may have rays forming zigzag pattern resembling a series of W's, may have all rays continuous, or may have a mixture of continuous and zigzag rays 35
35. A. Posterior pseudocardinal tooth of left valve turned sharply dorsad and that portion of hinge line interrupted by tooth; surface of shell having numerous W-shaped green rays, few continuous green rays ..... *Truncilla donaciformis* p. 114
    B. Posterior pseudocardinal tooth of left valve usually straight, not turned sharply dorsad; surface of shell having few or no W-shaped green rays, having numerous thin green rays ..... *Truncilla truncata* p. 111

36. A. Epidermis of shell having small dark brown or green rays extending from umbo to ventral margin and breaking to form small blocks or squares 37
B. Epidermis usually lacking rays from dorsal to ventral margins; if present never broken into small blocks or squares. 38
37. A. Umbo greatly compressed ..... *Plagiola lineolata* p. 117
B. Umbo moderately inflated ..... *Cyprogenia aberti* p. 105
38. A. Umbo cavity shallow, barely extending under the interdentum ..... *Elliptio dilatatus* p. 80
B. Umbo cavity deep, extending under the interdentum 39
39. A. Shell having lateral and posterior ridges. . *Plethobasus cyphyus* p. 68
B. Shell having posterior ridge, lacking lateral ridge 40
40. A. Shell quadrate; posterior margin of shell at nearly right angles to dorsal and to ventral margins. (nonpustulose) *Quadrula pustulosa* p. 55
B. Shell not quadrate, posterior margin of shell rounded or pointed 41
41. A. Posterior end of shell rounded, never pointed; umbones low, slightly inflated, not decidedly directed anteriorly. *Actinonaias carinata carinata* p. 108
B. Posterior end of shell pointed or bluntly pointed; umbones high, inflated, and directed anteriorly 42
42. A. Center of umbo posterior to posterior border of anterior adductor muscle scar; shape of shell forming a scalene triangle ◺ ..... *Fusconaia flava* p. 39
B. Center of umbo farther anterior, not posterior to posterior border of anterior adductor muscle scar; shape of shell forming an obtuse ◺ or right ◺ triangle 43
43. A. Anterior margin of shell usually straight; anterior edge of umbo but slightly posterior to anterior margin of shell; center of umbo anterior to posterior border of anterior adductor muscle scar; umbo greatly inflated. *Pleurobema coidatum pyramidatum* p. 76
B. Anterior end of shell slightly or distinctly curved; anterior edge of umbo not close to anterior margin of shell; center of umbo not anterior to (directly above) posterior border of anterior adductor muscle scar; umbo moderately inflated 44
44. A. Shell inflated ..... *Pleurobema cordatum catillus* p. 74
B. Shell flattened ..... *Pleurobema cordatum coccineum* p. 71

ACCOUNTS OF SPECIES

Introduction

The abbreviated synonymy under each technical name consists of the following:

1) original proposal of the name,
2) first usage of the current name-combination,
3) standard treatise in which a more nearly complete synonymy is given,
4) citations to previous records of the species or subspecies in Kansas.

When more than one usage is listed under any one of the four categories mentioned above, the usages are arranged in chronological order.

The type locality for each species is given as accurately as possible; unfortunately early workers did not always precisely indicate the locality from which the type specimen was obtained.

No attempt has been made to redescribe each of the species of the Unionidae in Kansas; descriptions given are adapted from those of Walker (1918), Simpson (1914), and Baker (1928), and are modified on the basis of personal observation.

The ecology of each species is discussed, including the type of stream bottom inhabited. If habitats occupied in Kansas differ from those noted by other authors, this difference is indicated.

Wherever possible the host fishes for the glochidia are given. This inadequately studied but extremely important aspect of unionid life history needs additional and more careful study. Common and scientific names of fishes are, in so far as possible, those recommended by Chute (1948) and Bailey (1951, 1952, 1953, and 1956).

Finally, remarks are made concerning the following aspects:

1) minor variations of the shell of species and subspecies in Kansas, as compared with the form in the Mississippi Valley,
2) variations of the shells of the species within the state,
3) economic value of the shell, appearance of the nacre, drying qualities of the shell and various facts concerning the species that might be of interest,
4) the largest specimens of each species recorded from Kansas.

Species reported have been collected in Kansas within the past ten years (except *Cyprogenia aberti*, Scammon, 1906, and *Dysnomia triquetra*, Scammon, 1909). Catalogue numbers refer to, and all specimens are deposited in, the mollusk collections of the Museum of Natural History, The University of Kansas.

Maps and Illustrations

The distribution maps illustrate the presently known range of the species within Kansas. The insert map of North America on each distribution map indicates the approximate distribution of the species as recorded in the literature.

Black dots (•) indicate localities from which specimens have been studied by us; circles (o) represent localities of specimens cited in literature that have not been available for study, but which are thought to represent valid records. Any single symbol on the map may include one or more actual collecting sites. In the account of each species under "Occurrence in Kansas," the exact western-most localities for that species in Kansas have been given.

Every effort has been made in Plates 5-44, to reproduce photographically the shells of each species in a manner most useful to those who attempt to identify shells without the aid of a reference collection. Interior views were illuminated at right angles to the shell with a diffusion ring between the light source and the specimen. In most cases the muscle scars have been painted with water colors in order to denote the size, shape, and position of the scars. External views were photographed with two equidistant lights; a diffusion ring was placed between the light source and the specimen.

PHYLUM MOLLUSCA

Class Pelecypoda

ORDER EULAMELLIBRANCHIA

Family Unionidae

Subfamily Unioninae

Genus Fusconaia Simpson 1900

Shell round, rhomboid, triangular or short, elliptical, having moderate posterior ridge; beaks high, full, curved inward and forward; beak sculpture of few coarse, parallel ridges, curving upward behind; epidermis dark; surface not sculptured; hinge plate of moderate width; pseudocardinals strong; nacre white, salmon or purple (after Walker, 1918, p. 48). Type: *Unio trigonus* Lea.

Wabash Pig-Toed Mussel

Fusconaia flava (Rafinesque)

Plate 5, figures 1-4; text figure 1

Obliquaria flava Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:305, pl. 81, figs. 13, 14.

Fusconaia flava, Ortmann, 1919, Mem. Carnegie Mus., 8:14; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:399; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Quadrula rubiginosa, Scammon, 1906, Univ. Kansas Sci. Bull., 3:359; Simpson, 1914, A descriptive catalogue . . . mussels, p. 872.

Unio rubiginosus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 122; Call, 1886, *op. cit.*, p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

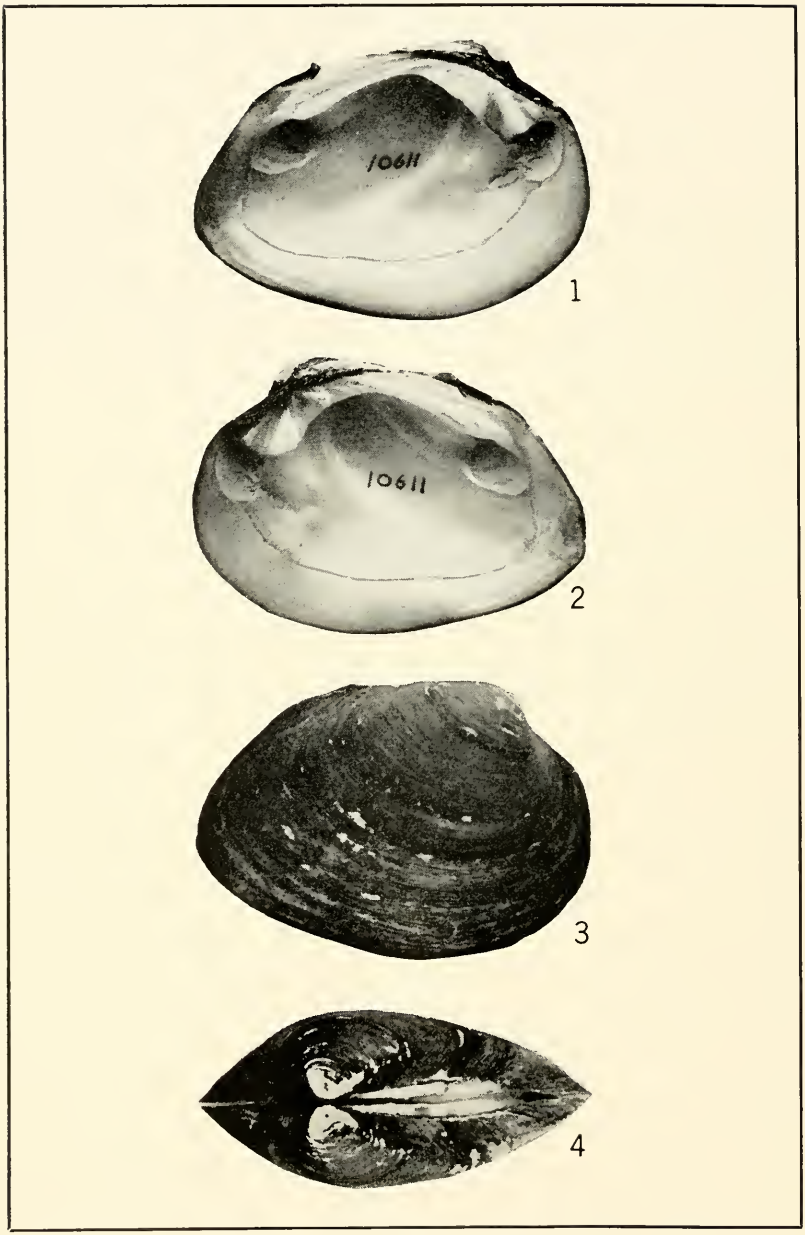
Type Locality: Small tributaries of Kentucky, Salt, and Green rivers.

General Distribution: Entire Mississippi River Drainage from western New York to eastern Kansas, Nebraska, South Dakota, and Texas; St. Lawrence River; Nelson River; Red River of the North; southern Ontario, Canada (Baker, 1928, p. 55; Strecker, 1931, p. 30; La Rocque, 1953, p. 91).

Occurrence in Kansas: Fusconaia flava is common in the rivers of the southeastern drainages. It has been recovered from several localities in southern tributaries of the Kansas River.

The westernmost records for *F. flava* in Kansas are: Kansas River, Topeka, Shawnee County (specimen not seen); 3½ mi. W and 2¼ mi. N Americus, Lyon County (sec. 20, T. 17 S, R. 10 E); 4 mi. E and 2 mi. S Hamilton, Greenwood County (sec. 21, T. 24 S, R. 12 E); Fall River, Eureka, Greenwood County (specimen not seen); Elk River, 1½ mi. W Elk Falls, Elk County (sec. 34, T. 30 S, R. 11 E).

PLATE 5



Fusconaia flava (Rafinesque), no. 10611; from Neosho River, at a place 1½ mi. E and 1 mi. S St. Paul, Neosho Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 3¼ inches.

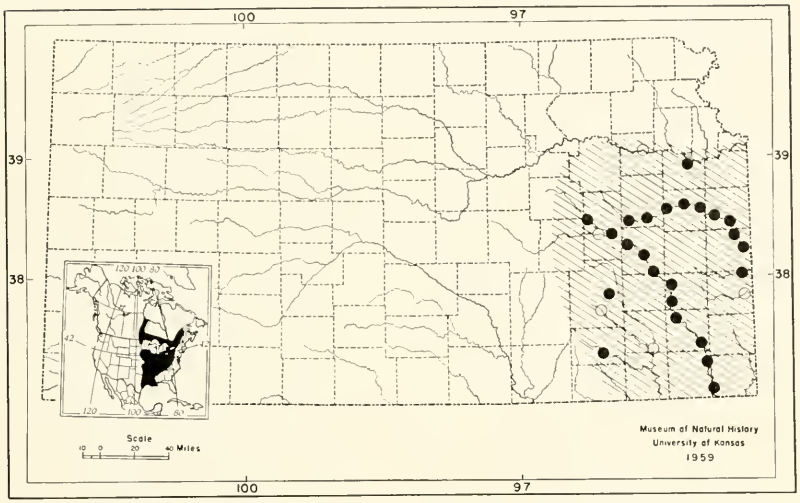


FIG. 1. Distribution of *Fusconaia flava* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell elongate-quadrate, thin to solid, inequipartite to equipartite, compressed to rather inflated; beaks slightly elevated, somewhat inflated, turned forward; anterior end rounded, truncated above and meeting dorsal line at sharp angle; posterior end obliquely truncated; dorsal margin slightly curved or straight; basal margin straight, slightly curved, or having slight emargination; posterior ridge conspicuous, roundly angled, having more or less distinct depression in front and usually ending in point at basal margin; surface marked only by growth lines that may form slight ridges; epidermis brownish or reddish, having tinge of green, faintly rayed in juvenile, dark and uniform in old individuals.

Two elevated, triangular, elongated, serrated pseudocardinals in left valve; one large, biangular, elevated pseudocardinal in right valve; usually a denticle anterior to and one posterior to pseudocardinal of right valve; laterals long, straight, elevated, double in left, inclined to double in right valve; interdentum slight, narrow or absent; anterior muscle scar deeply impressed; posterior scar well marked; beak cavities deep, broad; nacre whitish to salmon, iridescent posteriorly (after Baker, 1928, p. 53.) Although *F. flava* is probably the only representative of the genus in Kansas, we include a detailed description of the species in case *F. ebenus* or *F. undata* occur in the state.

Ecology: In Kansas *F. flava* can be found in all habitats except those of shifting sand bottoms. It occurs in water no more than three inches deep, to pools from four to five feet deep.

Host for Glochidia: Not recorded.

Remarks: F. flava may be confused with but one other species in Kansas, *Pleurobema cordatum coccineum.* In *P. c. coccineum* the posterior ridge is reduced to a rounded swelling or is lacking; the entire shell is more roundly oblique, and the pseudocardinals are more massive and less elevated.

In addition to *F. flava,* Scammon (1906, p. 360, 366) reported *F. undata* and *F. ebenus,* which he did not illustrate. The *F. undata* in his Arkansas collection we identify as *F. flava. F. ebenus* and *F. undata* may still occur in Kansas, but no authentic records are known in the last 54 years.

F. flava was valued for buttons. The nacre is white in juveniles but in some older individuals has yellow blemishes or a salmon tint. Large specimens from Kansas are 4 to 4½ inches long.

Genus MEGALONAIAS Utterback 1915

Shell large, heavy, obovate or rhomboid, alate posteriorly; dics obliquely folded; beak sculpture of coarse, doubly looped corrugations extending over upper surface of disc as nodulous plications; epidermis dark-brown or blackish; beak cavities narrow and deep; anterior muscle scars deep, filled by nacreous deposit; posterior scars large, indistinct (after Walker, 1918, p. 46). Type: *Unio heros* Say.

Giant Washboard Mussel

Megalonaias gigantea (Barnes)

Plate 6, figures 1-4; text figure 2

Unio giganteus Barnes, 1823, Amer. Jour. Sci., 6:119 [as variety of *U. crassus* (Say)].

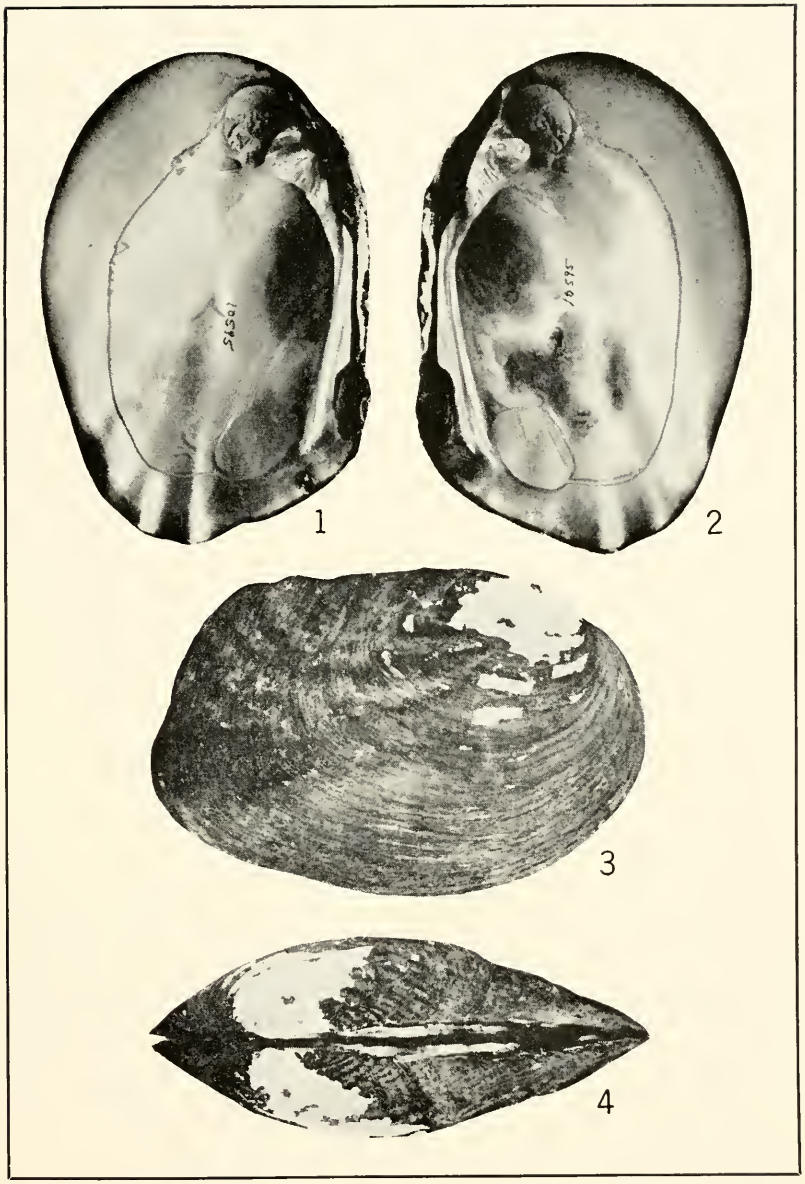
Megalonaias gigantea, Ortmann and Walker, 1922, Occas. Papers Mus. Zool., Univ. Michigan, no. 112, p. 7.

Quadrula heros, Scammon, 1906, Univ. Kansas Sci. Bull., 3:346; Simpson, 1914, A descriptive catalogue . . . mussels, p. 825.

Type Locality: Mississippi River, Prairie du Chein.

General Distribution: Throughout the Mississippi River drainage, west to eastern Texas, Kansas, Iowa, and Wisconsin; Red River of the North; Manitoba, Canada; Tombigbee River, Alabama; Nuevo León, Northern México.

PLATE 6



Megalonaias gigantea (Barnes), no. 10595; from Neosho River, 2 mi. W St. Paul, Neosho Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 7⅞ inches.

Occurrence in Kansas: Megalonaias gigantea is common in the lower Neosho River but rare in the Marais des Cygnes River. Although there are no valid records from the Verdigris River, it probably occurs there. *Unio undulatus* reported by Call (1885-1887) includes *Crenodonta peruviana costata* and *M. gigantea;* therefore, it is not possible to give accurate localities for Call's records for these two mentioned species.

The westernmost records for *M. gigantea* in Kansas are: Marais des Cygnes River, 4 mi. S and 4 mi. E Admire, Lyon County; Neosho River, ½ mi. S Ottumwa, Coffey County.

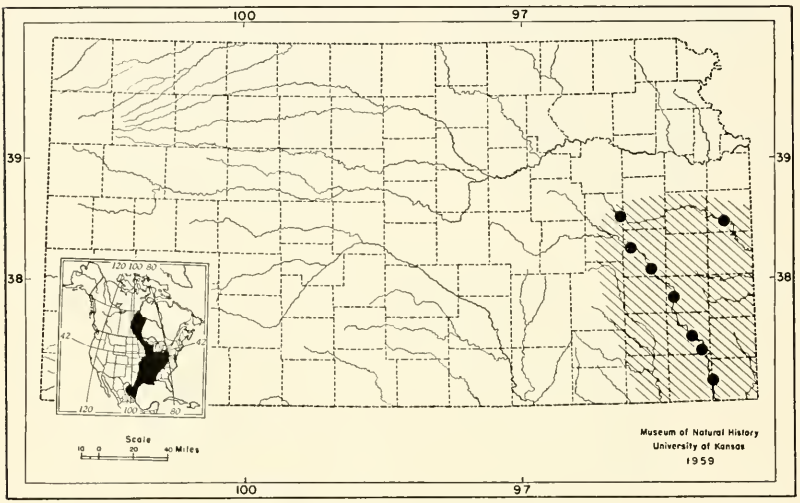


FIG. 2. Distribution of *Megalonaias gigantea* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of shell: Since this is a monotypic genus, the generic description applies.

Ecology: M. gigantea typically occurs in quiet places in muddy bottoms in large streams having deep water. Scammon (1906, p. 347) believed this mussel to be rare in Kansas; however we believe his opinion was erroneous and resulted from the fact that this species inhabits deep water even during the breeding season when other mussels are in shallow water. The senior author (Murray) has never collected living *M. gigantea* in water less than 6 feet deep. Where collected in deep water other species of mussels were obtained nearby in shallower water.

Host for Glochidia: The glochidia occur on the fins of gizzard shad, *Dorosoma cepedianum;* white crappie, *Pomoxis annularis;* on the gills of white bass, *Roccus chrysops;* bowfin, *Amia calva;* flathead catfish, *Pylodictis olivaris* (Baker, 1928, p. 72).

Remarks: This is the largest unionid in the Mississippi River drainage. Haas (1941, p. 261) reported the largest known specimens from the Salt River, Kentucky, to be 280 mm. (approximately 11 inches) long. Several, measuring 210 mm. (approximately 8⅜ inches long) have been recovered from the Neosho River.

M. gigantea may be confused with members of the genus *Crenodonta,* but differs in having distinct zigzag sculpturing on the beak of young individuals, and in old specimens being larger and more elongate.

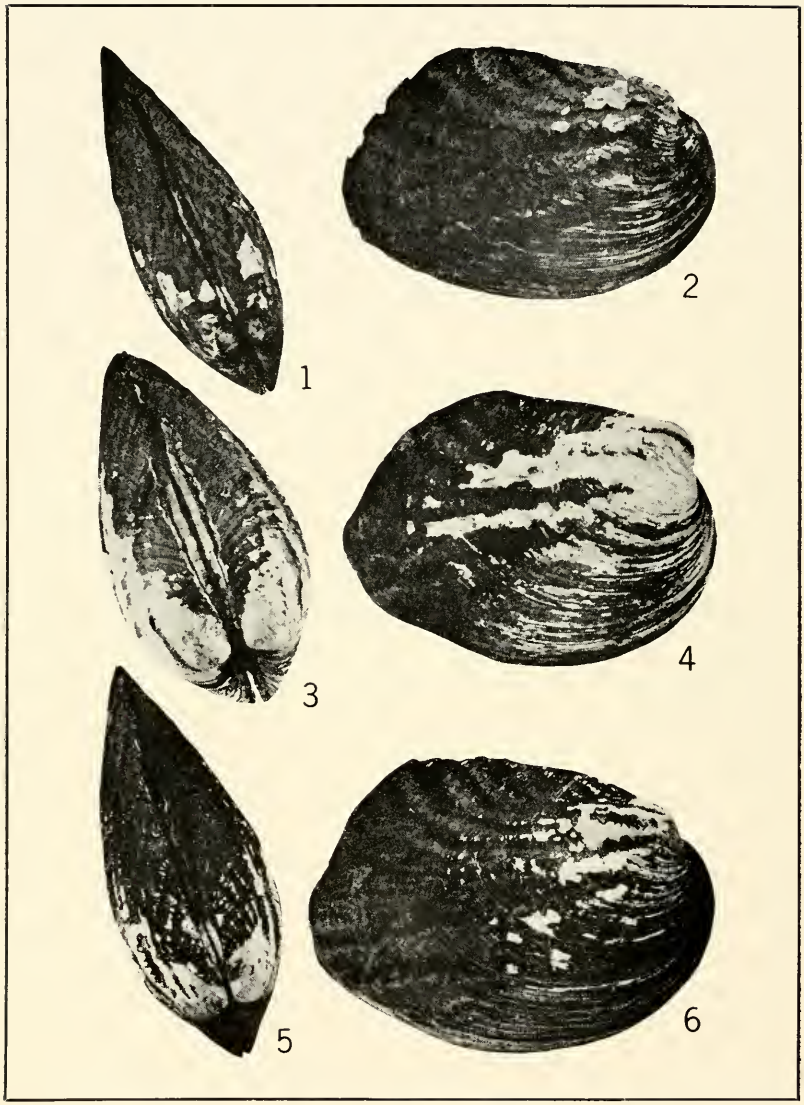
Because of its large size, this species was highly valued for buttons. Large living specimens frequently burrow so deeply into the mud that it requires the strength and both hands of an adult to free the mussel. The drying qualities of the shell are excellent, although shells of some older specimens are marked with brownish blotches.

Genus CRENODONTA Schlüter 1838

Shell subquadrate to subtrapezoidal in outline, thick; umbones somewhat elevated, sculptured by coarse, double looped corrugations extending over upper part of disc; sculpture on shell of large diagonal plicae; epidermis dark brown to nearly black; pseudocardinal teeth relatively large and ragged; lateral teeth long and well developed; nacre iridescent (after Clench and Turner, 1956, p. 157). Type: *Unio plicatus* Say.

The name *Crenodonta* Schlüter is here used instead of the familiar name *Amblema* Rafinesque. Clench and Turner (1956, p. 157) point out that *Amblema* was proposed by Rafinesque in 1819 as a monotypic genus based on *A. ovalis* Rafinesque. This species is unknown and unrecognizable. Rafinesque subsequently used *Amblema* in 1820, but did not mention *A. ovalis;* instead he referred *A. costata* to the genus. The proposal of Clench and Turner (*loc. cit.*) to discard *Amblema* Rafinesque in favor of *Crenodonta* Schlüter, is the simplest temporary solution to this problem.

PLATE 7



Crenodonta peruviana costata (Rafinesque), no. 5673; from Marais des Cygnes River, at a place 2 mi. E and 1¼ mi. S Pomona, Franklin Co., Kansas. Fig. 1, dorsal aspect of shell; fig. 2, exterior, right valve. Actual length, 5 inches.

Crenodonta peruviana peruviana (Lamarck), no. 11272; from Neosho River, 4 mi. W Erie, Neosho Co., Kansas. Fig. 3, dorsal aspect of shell; fig. 4, exterior right valve. Actual length, 5⅛ inches.

Crenodonta peruviana costata (Rafinesque), no. 11286; from Marais des Cygnes River, at a place 3 mi. N and 3¾ mi. E Admire, Lyon Co., Kansas. Fig. 5, dorsal aspect of shell; fig. 6, exterior, right valve. Actual length, 5½ inches.

Blue-Point Mussel

Crenodonta peruviana peruviana (Lamarck) new combination

Plate 7, figures 3, 4; text figure 3

Unio peruviana Lamarck, 1819, An. saus Vert., 6:71.

Unio plicatus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.,* p. 96; Call, 1885, *op. cit.,* p. 121; Call, 1886, *op. cit.,* p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

Quadrula plicata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:341; Simpson, 1914, A descriptive catalogue . . . mussels, p. 814.

Type locality: Unknown, erroneously given as Peru.

General Distribution: Entire Mississippi River drainage from western New York west to eastern Kansas and Texas, north to Minnesota and south to Louisiana; Alabama River drainage; St. Lawrence drainage; Red River of the North; Saskatchewan River, Lake Winnipeg (Simpson, 1914, p. 815; La Rocque, 1953, p. 87). The subspecies *Crenodonta peruviana peruviana* is restricted to the larger streams and rivers of the areas mentioned above. The above distribution includes *C. p. costata.*

Occurrence in Kansas: C. p. peruviana occurs in the larger portions of the Neosho, Marais des Cygnes, Verdigris, and Kansas rivers. In the Neosho River the subspecies extends no farther north than the southern border of Allen County. In the Verdigris River it probably extends as far north as Wilson County. It extends west in the Marais des Cygnes as far as the eastern edge of Franklin County, and in the Kansas River it may extend as far west as Riley County. It is abundant in the areas mentioned.

The westernmost records for *C. p. peruviana* in Kansas are: Wild Cat Creek, Riley County (specimens not seen); Marais des Cygnes River, 4 mi. W and 1½ mi. N Osawatomie, Miami County (sec. 36, T. 17 S, R. 21 E); Neosho River, 1½ mi. E and 1 mi. S Chanute, Neosho County (sec. 27, T. 27 S, R. 18 E); Verdigris River, Neodesha, Wilson County (specimen not seen).

Description of Shell: Shell subquadrate, inflated, solid, inequipartite; beaks elevated, inflated, turned forward; beak sculpture of several irregular, heavy ridges somewhat nodulous on posterior slope; posterior ridge rounded, not prominent, having shallow depression above; anterior end rounded; posterior end almost squarely truncated; ventral margin slightly rounded; dorsal margin almost straight, produced into a wing posteriorly; surface having several oblique folds or plications, usually parallel to posterior ridge; plications usually absent from winglike area above ridge; growth lines

coarse; epidermis light greenish becoming brown or black in older specimens; some young individuals have faint rays.

Two strong, triangular, rough, divergent pseudocardinals in left valve, in some individuals split into radial sulci; one large, triangular, radially sulcated pseudocardinal in right valve, having small, triangular, sulcated tooth in front; interdentum more or less sulcated posteriorly; two almost straight laterals in left valve, one in right

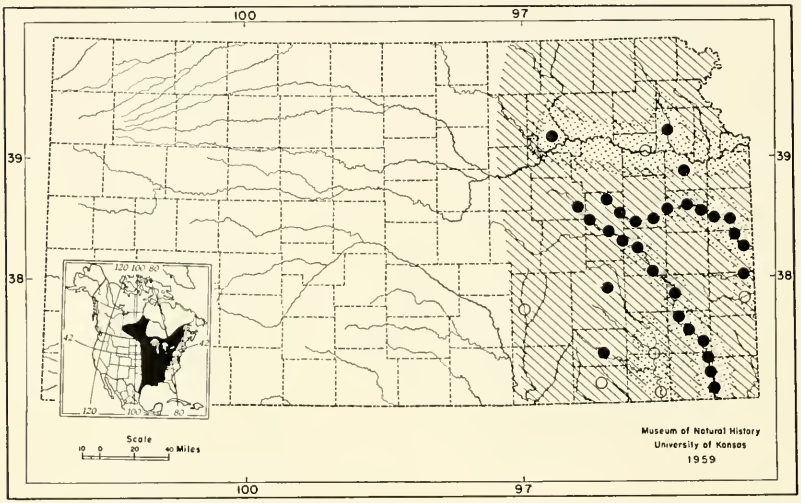


FIG. 3. Distribution of *Crenodonta peruviana peruviana* (dots) and *C. p. costata* (lines) in Kansas. Areas of intergradation are indicated by overlap of lines and dots. Insert map shows approximate distribution for both subspecies in North America.

valve, double posteriorly in some examples; beak cavities deep; anterior muscle scars deeply impressed, sulcate; nacre white, iridescent posteriorly (after Baker, 1928, p. 73).

Ecology: In Kansas *C. p. peruviana* inhabits most types of stream bottoms, except shifting sand, in deep water (2-8 feet).

Host for Glochidia: The glochidia occur on white crappie, *Pomoxis annularis*, and black crappie, *P. nigromaculatus* (Baker, 1928, p. 74).

Remarks: C. p. peruviana can be distinguished from *C. p. costata* by the higher and more inflated umbones, less prominent plicae on the dorsoposterior area, more massive pseudocardinal teeth, and wider and longer interdentum in *C. p. peruviana.* Specimens that do not have the correlated set of diagnostic characteristics mentioned above are regarded as intergrades, and many of these

cannot be assigned satisfactorily to subspecies. Intergrades were obtained in Coffey, Allen, and Franklin counties. Other areas of intergradation as shown in figure 3 are assumed on the basis of meager data. The cause of this variation in *Crenodonta* is not known, but may result from ecological differences between large and small streams.

The shell was valued for buttons. Some older specimens have large areas of the umbones eroded, which hinders identification. Large specimens from Kansas range from 5 to 5½ inches long.

Three-Ridged Mussel

Crenodonta peruviana costata (Rafinesque) new combination

Plate 7, figures 1, 2 and 5, 6; text figure 3

Amblema costata Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:315, pl. 82, figs. 13, 14; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:395; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Unio undulatus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 122; Call, 1886, *op. cit.*, p. 183; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:23.

Quadrula undulata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:344; Simpson, 1914, A descriptive catalogue . . . mussels, p. 819.

Type Locality: Ohio River and small tributaries of Kentucky River.

General Distribution: Approximately the same as *Crenodonta peruviana peruviana* (page 48, text figure 3), but extending into smaller streams of the same major river sytems.

Occurrence in Kansas: C. p. costata occurs in lakes and small streams throughout the eastern one-fourth of Kansas. It is extremely abundant in the upper portions of the Marais de Cygnes and Neosho rivers. It is not generally found in the main channel of the Neosho River south of Allen County, main channel of the Marais des Cygnes River east of Franklin County, or main channels of the Kansas River east of Riley County.

Description of Shell: Shell elongate-quadrate, solid, inequipartite, subinflated to compressed; beaks depressed or but slightly elevated, not much inflated; beak sculpture of a few well-marked ridges; posterior ridge broad, rounded, not conspicuous; dorsal margin straight or slightly curved; basal margin broadly rounded to straight; anterior end rounded; posterior end rather sharply truncated, rounded into base posteriorly; surface having rounded ridges or folds parallel to posterior ridge; numerous small radial ridges on posterior wing; frequently a few elongated pustules present on posterior half of valve; epidermis greenish or yellowish-green in

young individuals, sometimes slight indications of rays; old individuals having dark brown or black epidermis.

Two large, triangular, elevated, radially sulcated pseudocardinals in left valve; one large, triangular, sulcated tooth in right valve, having small lamellar, divergent ridge in front, in some individuals a third subobsolete tooth posteriorly; two long, almost straight laterals in left valve, one in right; interdentum narrow; anterior muscle scars deeply impressed, roughened by addition of shelly matter; posterior scars wide, distinct but not impressed; beak cavities compressed, deep; nacre white, iridescent posteriorly; frequently dark brown blotches on nacre of shell (after Baker, 1928, p. 80).

Ecology: *C. p. costata* occurs in small streams on all Kansas stream bottoms, except shifting sand. It is common in pondlike areas of streams in water 1-5 feet deep. Contrary to statements by Ortmann (1919, p. 32) and Baker (1928, p. 82) concerning its preferred habitat, it is frequently abundant on mud bottoms in streams in Kansas.

Remarks: The differences between *C. p. peruviana* and *C. p. costata* are discussed under the former.

Large specimens from Kansas range from 5 to 5½ inches long but average somewhat smaller than those of *C. p. peruviana.*

Genus QUADRULA Rafinesque 1820

Shell triangular, quadrate or rhomboid, solid, inflated; coarse, prominent beaks having irregular, subparallel ridges, inflated as they cross posterior ridge; posterior ridge well developed; epidermis dull-colored, dark, rayless or feebly rayed; hinge plate wide, flattened; pseudocardinals solid, direct, ragged; laterals double in left, single in right valve; beak cavity deep, compressed (after Walker, 1918, p. 43). Type: *Quadrula quadrula* Rafinesque.

Maple-Leaf Mussel

Quadrula quadrula Rafinesque

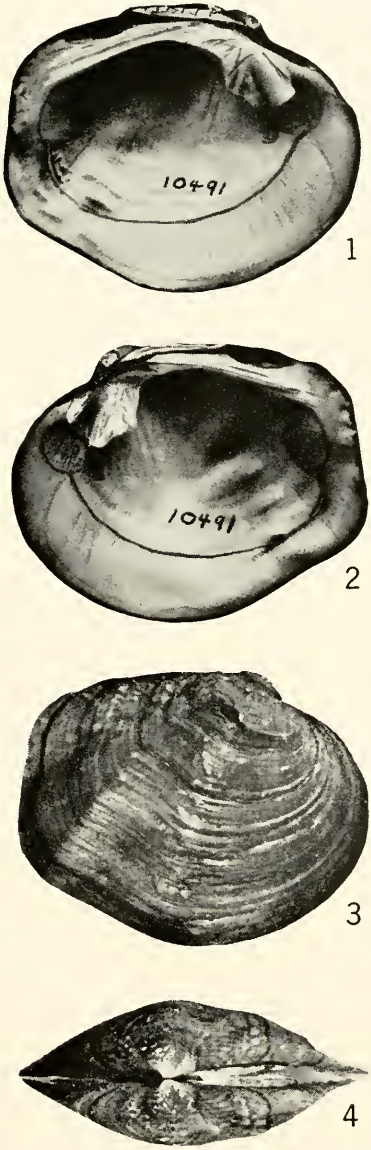
Plate 8, figures 1-4; text figure 4

Obliquaria (*Quadrula*) *quadrula* Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:307.

Quadrula quadrula, Simpson, 1914, A descriptive catalogue . . . mussels, p. 848; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:397; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Unio lachrymosus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.,* p. 96; Call, 1885, *op. cit.,* p. 120; Call, 1886, *op. cit.,* p. 181; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21.

PLATE 8



Quadrula quadrula Rafinesque, no. 10491; from Neosho River, at a place ½ mi. N and 3 mi. W Neosho Rapids, Lyon Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 3⅛ inches.

Unio asperrimus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:116; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19.

Quadrula lachrymosa, Scammon, 1906, Univ. Kansas Sci. Bull., 3:351; Clark and Gillette, 1911, Proc. Biol. Soc. Washington, 24:66.

Type Locality: Ohio River.

General Distribution: Throughout the Mississippi River drainage; various localities on the St. Lawrence River basin; Red River of the North (La Rocque, 1953, p. 98).

Occurrence in Kansas: Quadrula quadrula is common throughout the eastern one-half of Kansas. Although there are no records of this species in the extreme western portion of the state, it may occur there as isolated populations.

The westernmost records of *Q. quadrula* in Kansas are: Smoky Hill River, Salina, Saline County; Little and Big Arkansas rivers, Wichita, Sedgwick County; Walnut River near Arkansas City, Cowley County. Specimens from the above localities have not been examined by us.

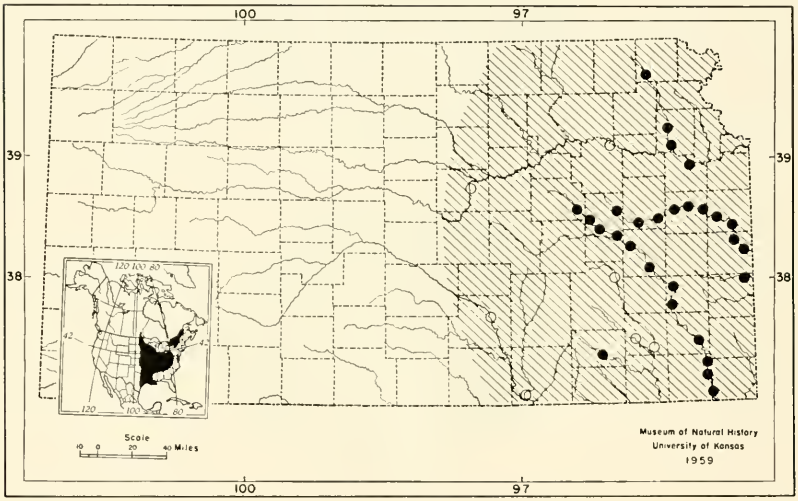


FIG. 4. Distribution of *Quadrula quadrula* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell quadrate, compressed, solid; beaks elevated, moderately inflated; posterior ridge well developed; anterior end rounded; posterior end usually sharply truncated; basal margin having wide sinus in middle; ventral border arcuate; depression in front of posterior ridge dividing valve into two parts; shell sculpture of lachrymose or elongate tubercules arranged in 3 series,

one series on median sulcus, one series on umbonal ridge, one series on posterior wing; tubercules on posterior wing elongated, radial, those on umbones small, rounded, those lower on valve elongate; lower area of mature shells frequently lacking pustules; epidermis yellowish-green in young, brownish to black in old individuals.

Two roughly triangular, sulcated, roughened pseudocardinals in left valve; single, triangular sulcated pseudocardinal in right valve; usually one small denticle anterior, one posterior to pseudocardinal of right valve; interdentum wide, flat; laterals long, curved slightly, right valve double; anterior muscle scars deeply impressed, posterior scars distinct; beak cavities deep, compressed; nacre white, iridescent posteriorly (after Baker, 1928, p. 84).

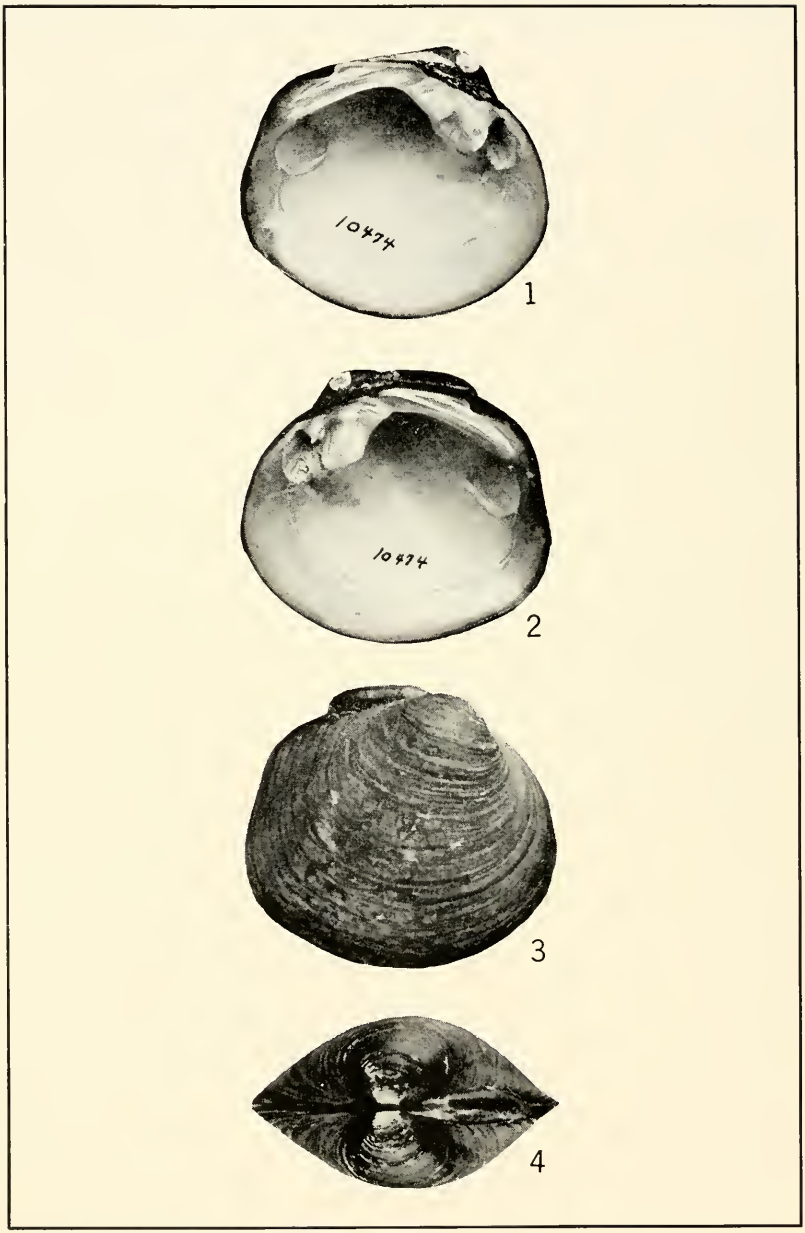
Ecology: The maple-leaf mussel occurs in muddy, rocky, gravelly, and sandy bottoms in shallow to deep water. It does not live in areas of shifting sand.

Host for Glochidia: Coker (1919, p. 23) reports the glochidia as parasitic on several species of catfish.

Remarks: In Kansas *Q. quadrula* has been confused with *Q. fragosa.* Call (1885-1887) and Scammon (1906) reported *Q. fragosa* in Kansas. Scammon's illustration of *Q. fragosa* is a highly pustulated *Q. quadrula.* A single valve in Scammon's collection which was identified by him as *Q. fragosa* is also a highly pustulose *Q. quadrula.* Scammon differentiated the two species in Kansas on the basis of the number of tubercules and plications on the shell. Because there are no *Q. fragosa* from Kansas in our collections, we conclude that *Q. fragosa* as reported from Kansas is actually *Q. quadrula.* It is not possible to determine whether or not Call actually had specimens of *Q. fragosa.*

As the supply of other shells diminished from the Mississippi River drainages, the value of this shell was realized; however, the irregular pustulations and frequent brownish blemishes on the nacre lowered the value of the shell. The drying qualities of the shell are excellent, and young specimens present an interesting and unusual pattern for novelties. Large specimens from Kansas range from 5 to 5½ inches in length.

PLATE 9



Quadrula pustulosa (Lea), no. 10474, from Neosho River, at a place 2 mi. W and 2¼ mi. N Emporia, Lyon Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 2⅞ inches.

Pimple-Backed Mussel

Quadrula pustulosa (Lea)

Plate 9, figures 1-4; text figure 5

Unio pustulosus Lea, 1831, Trans. Amer. Phil. Soc., 4:76, pl. 7, fig. 7; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 121; Call, 1886, *op. cit.*, p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

Quadrula pustulosa, Baker, 1898, Chicago Acad. Sci. Bull. III, pt. I, p. 86, pl. 25, fig. 2, pl. 28, fig. 13; Scammon, 1906, Univ. Kansas Sci. Bull., 3:354; Clark and Gillette, 1911, Proc. Biol. Soc. Washington, 24:66; Simpson, 1914, A descriptive catalogue . . . mussels, p. 848; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:398; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Unio dorfeuillianus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50.

Type Locality: Ohio.

General Distribution: Mississippi drainage; Michigan; Lake Erie (Simpson, 1914, p. 849).

Occurrence in Kansas: Quadrula pustulosa commonly occurs in the eastern half of the state, but if it occurs north of the Kansas River in the eastern portion of Kansas, it is indeed rare.

The westernmost records for *Q. pustulosa* in Kansas are: Neosho River, 3¾ mi. W and 2¼ mi. N Americus, Lyon County (sec. 29, T. 17 S, R. 10 E); Little Arkansas River, near Wichita, Sedgwick County (specimen not seen); Walnut River, Arkansas City, Cowley County (specimen not seen).

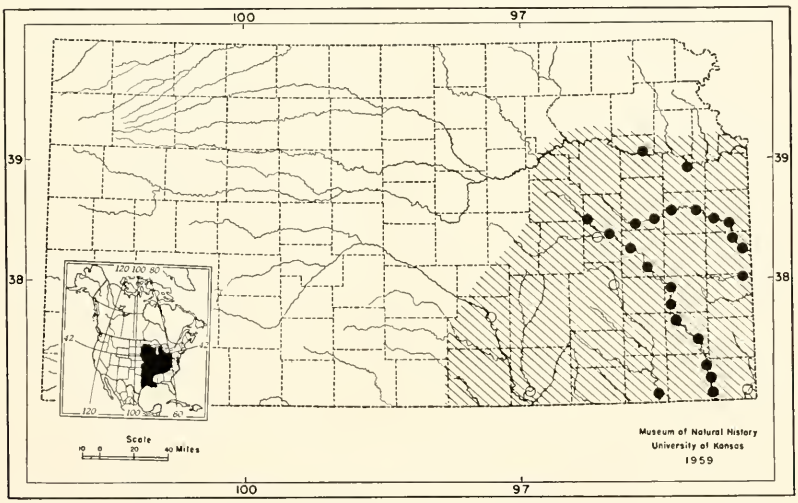


FIG. 5. Distribution of *Quadrula pustulosa* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell subquadrate, subrhomboid or suborbicular, inflated, solid, inequipartite; beaks high, swollen, turned forward; lunule broad, deep; anterior end rounded; posterior end sharply truncated; basal margin slightly rounded; dorsal margin rounded; posterior two-thirds of surface having lachrymose or rounded tubercules on posterior wing, or smooth; young shells brownish or yellowish-green, old shells brown to black.

Two divergent, elongate, roughened pseudocardinals in left valve; one large, broadly triangular pseudocardinal in right valve; small denticles anterior and posterior to pseudocardinal in right valve; interdentum broad and flat; laterals straight, heavy, short; muscle scars excavated anteriorly, distinct posteriorly; beak cavities deep, somewhat compressed; nacre white, iridescent posteriorly, frequently blotched with brown (after Baker, 1928, p. 90).

Ecology: *Q. pustulosa* is found in all stream habitats except those of shifting sand. Specimens have been taken in water from 2 inches to 3 feet in depth. In Coffey County two individuals were found on a large slab of rock 100 feet in length and 5 to 10 feet wide in three feet of water. They had probably been washed from upstream to this unusual habitat.

Host for Glochidia: The glochidia have been recovered from the gill filaments of *Ictalurus punctatus,* channel catfish.

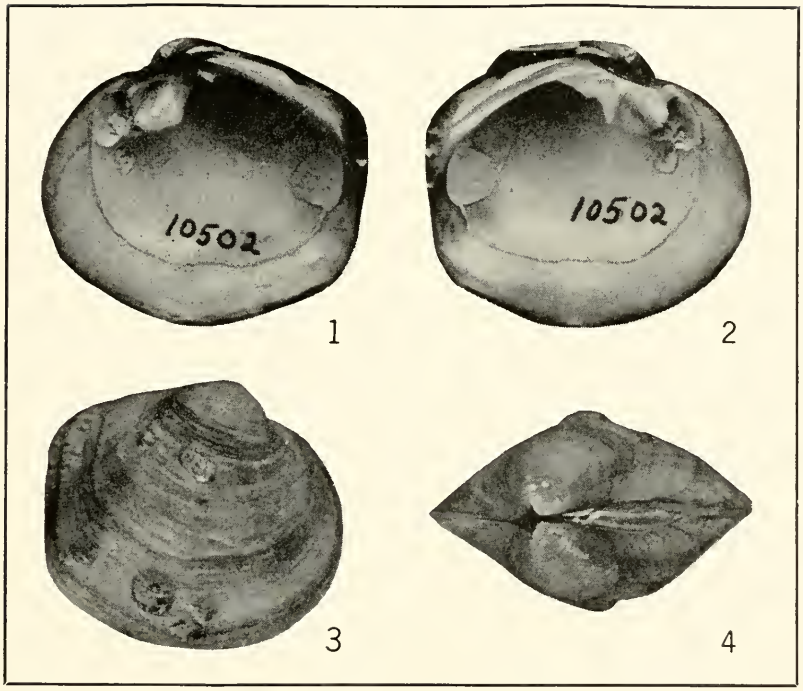
Remarks: In Kansas *Q. pustulosa* may be confused with *Q. nodulata.* The differences between these two species are discussed under *Q. nodulata.*

Along with *Q. quadrula* this is one of the most common species of unionids in Kansas. In areas of suitable habitat one should be able to collect several hundred specimens in an hour.

The shape and pustulations are highly variable in this species. Some immature and a few older examples lack pustulations. Young individuals are generally subquadrate, but more mature specimens vary from subrhomboid to suborbicular in shape.

Because of the even thickness of the shell and its abundance, it was highly valued for buttons. The nacre is a beautiful white, but brown blemishes frequently appear in the posterior edge of older shells. Large specimens from Kansas range from 3 to 3½ inches in length.

PLATE 10



Quadrula nodulata Rafinesque, no. 10502; from Neosho River, ¼ mi. N Strawn, Coffey Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 1¾ inches.

Warty-Backed Mussel

Quadrula nodulata Rafinesque

Plate 10, figures 1-4; text figure 6

Obovaria (*Quadrula*) *nodulata* Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:307, pl. 81, figs. 17, 18.

Quadrula pustulata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:356; Simpson, 1914, A descriptive catalogue . . . mussels, p. 856.

Unio pustulatus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:116; Call, 1886, *op. cit.*, p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

Type Locality: Kentucky River.

General Distribution: Entire Ohio, Cumberland, and Tennessee river systems; Mississippi River drainages from southeastern Minnesota south to Louisiana, west to southeastern Kansas, and northeastern Texas.

Occurrence in Kansas: *Quadrula nodulata* occurs rarely in the southern portion of the Neosho and Verdigris river drainages. The University of Kansas museum has but five specimens of this species from Kansas, all of which were collected at the localities shown on distribution map (text figure 6). Although no specimens were recovered south of the mapped localities, *Q. nodulata* probably occurs there.

The westernmost records for *Q. nodulata* in Kansas are: Neosho River, 7½ mi. E and 1¼ mi. S Emporia, Lyon County (sec. 24, T. 19

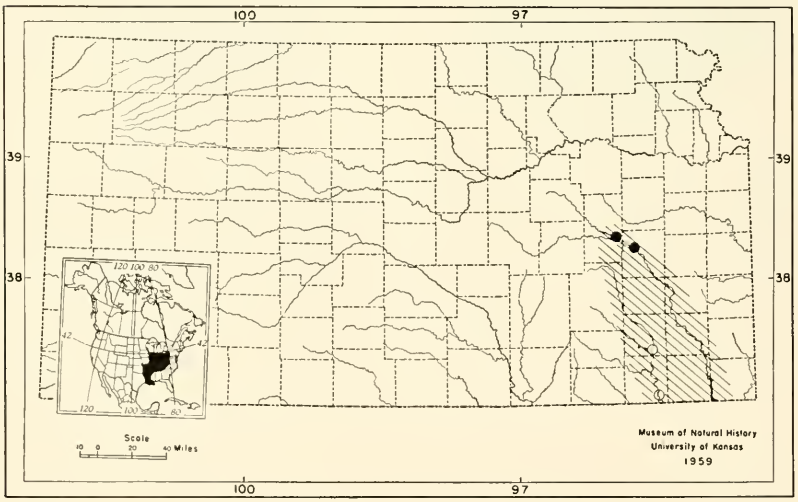


FIG. 6. Distribution of *Quadrula nodulata* in Kansas. Insert map shows approximate distribution of this species in North America.

S, R. 12 E); Verdigris River, Neodesha, Wilson County (specimen not seen).

Description of Shell: Shell subquadrate, slightly inflated, nearly equipartite; beaks elevated, swollen, turned forward over wide lunule; surface having large tubercules in two divergent imperfect rows, one row on posterior ridge, other row in front; usually having small pustules on dorsoposterior portion; epidermis yellowish-green to brownish-green, feebly rayed.

Two divergent, ragged pseudocardinals in left valve; one large, sulcate pseudocardinal in right valve; small denticles anterior and posterior to pseudocardinal in right valve; laterals slightly curved, double in left, single in right valve; interdentum narrow; beak cavities deep; anterior adductor scar deeply excavated, posterior scar faint; nacre white, iridescent posteriorly (after Baker, 1928, p. 95).

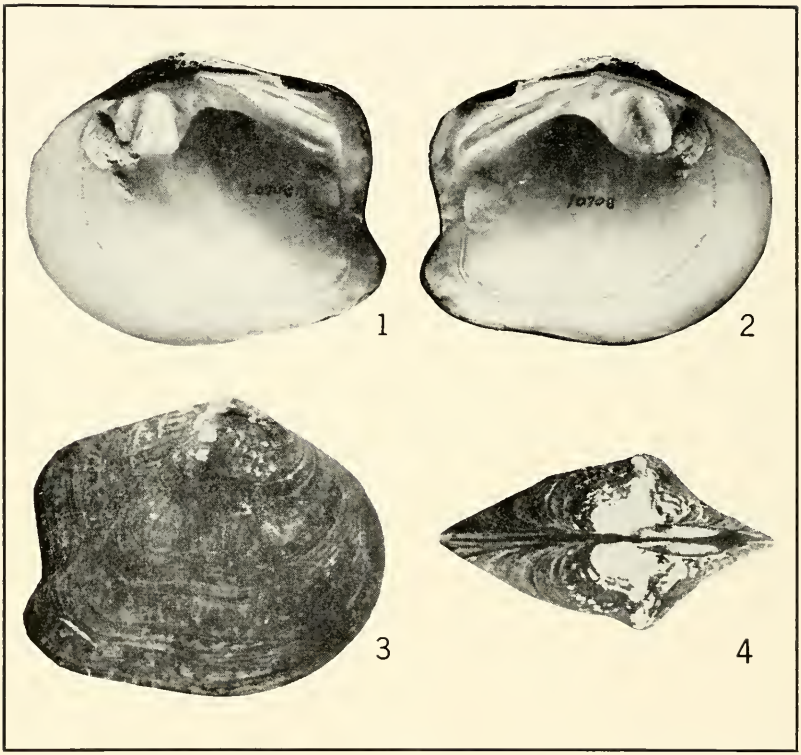
Ecology: Baker (1928, p. 96) reports that this species is found in large rivers where it usually lives in mud bottoms. *Q. nodulata* has been obtained from but two localities in Kansas; in both instances the animals were living in a rocky stream bottom having little mud.

Host for Glochidia: The glochidia have been reported from *Pomoxis annularis,* white crappie (Surber, 1913, p. 113). *P. nigromaculatus, Micropterus salmoides,* and *Lepomis macrochirus* have been artifically infected (Howard, 1914, p. 15). The glochidia infect the gills.

Remarks: Q. nodulata can be confused with *Q. pustulosa.* The former may be distinguished by its more quadrate form, by the presence of tubercules in two divergent rows, and by the somewhat lighter epidermis. *Q. nodulata* may be confused with *Obliquaria reflexa,* but is distinguished from the latter by having the tubercules of one valve opposite those of the opposing valve. The tubercles of *O. reflexa* alternate in position with those of the opposing valve.

Because of its small size and rare occurrence, *Q. nodulata* was not valued for buttons. The light straw-colored epidermis and beautiful white nacre make this a desirable shell for ornamental purposes. The largest specimen on record from Kansas is 2¼ inches long.

PLATE 11



Quadrula metanevra Rafinesque, no. 10708; from Neosho River, 12¾ mi. W Columbus, Cherokee Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 3½ inches.

Monkey-Faced Mussel

Quadrula metanevra Rafinesque

Plate 11, figures 1-4; text figure 7

Obliquaria (Quadrula) metanevra Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:305, pl. 81, figs. 15, 16.

Quadrula metanevra, Simpson, 1900, Proc. U. S. Nat. Mus., 23:774; Scammon, 1906, Univ. Kansas Sci. Bull., 3:349.

Unio metanevrus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:94; Call, 1885, *op. cit.,* p. 120; Call, 1886, *op. cit.,* p. 181; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21.

Type Locality: Kentucky River.

General Distribution: Mississippi River drainage except the southern portion, extending to Tennessee and Arkansas rivers (Simpson, 1914, p. 835).

Occurrence in Kansas: Quadrula metanevra is restricted to the drainages of southeastern Kansas. As a result of our collections on the Neosho River, we judge the present northernmost extent of range in Kansas to be the western edge of Coffey county. The localities indicated on the distribution map (figure 7) from the Neosho River in Lyon County are specimens obtained by Scammon, May 3, 1909. Recent studies indicate that this species probably does not extend north to Lyon County.

The westernmost records that we accept for *Q. metanevra* are: Cottonwood River, Emporia, Lyon County (specimen not seen)

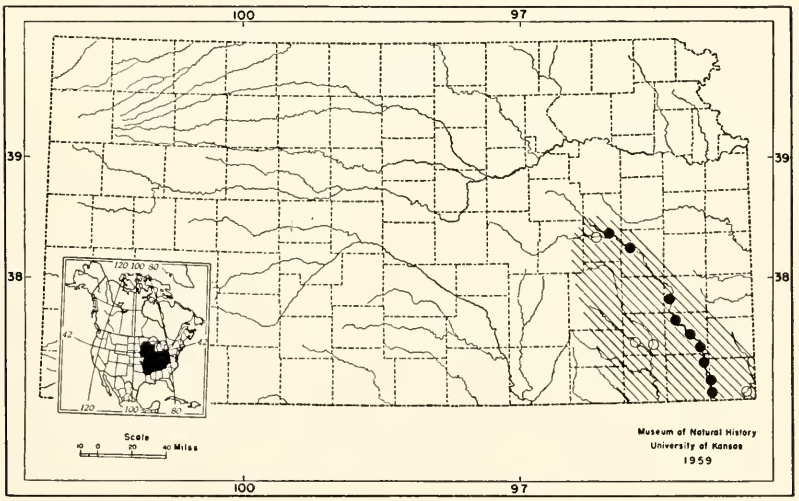


FIG. 7. Distribution of *Quadrula metanevra* in Kansas. Insert map shows approximate distribution of this species in North America.

and Fall River, Wilson County (specimen not seen). Both records were reported by Call (1887, p. 21).

Description of Shell: Solid, inequipartite, inflated, rhomboid; beaks high, inflated, directed forward; lunule narrow; anterior end rounded; posterior end sharply truncated having sinus above ridge; strong, wide, elevated ridge extending obliquely from umbo to posterior angle of shell, depression behind ridge; posterior two-thirds of shell usually having rounded or lacrymose tubercules; posterior ridge having elongated knobs; epidermis yellowish-green or brownish, having irregular, triangular chevron-shaped dark green markings.

Two heavy, triangular pseudocardinals in left valve; one triangular pseudocardinal in right valve, having small denticle in front, one behind; interdentum wide; laterals short, straight, heavy; anterior muscle scars deeply excavated; posterior scars distinct, not heavily impressed; beak cavities not deep; nacre white to pinkish (after Baker, 1928, p. 98).

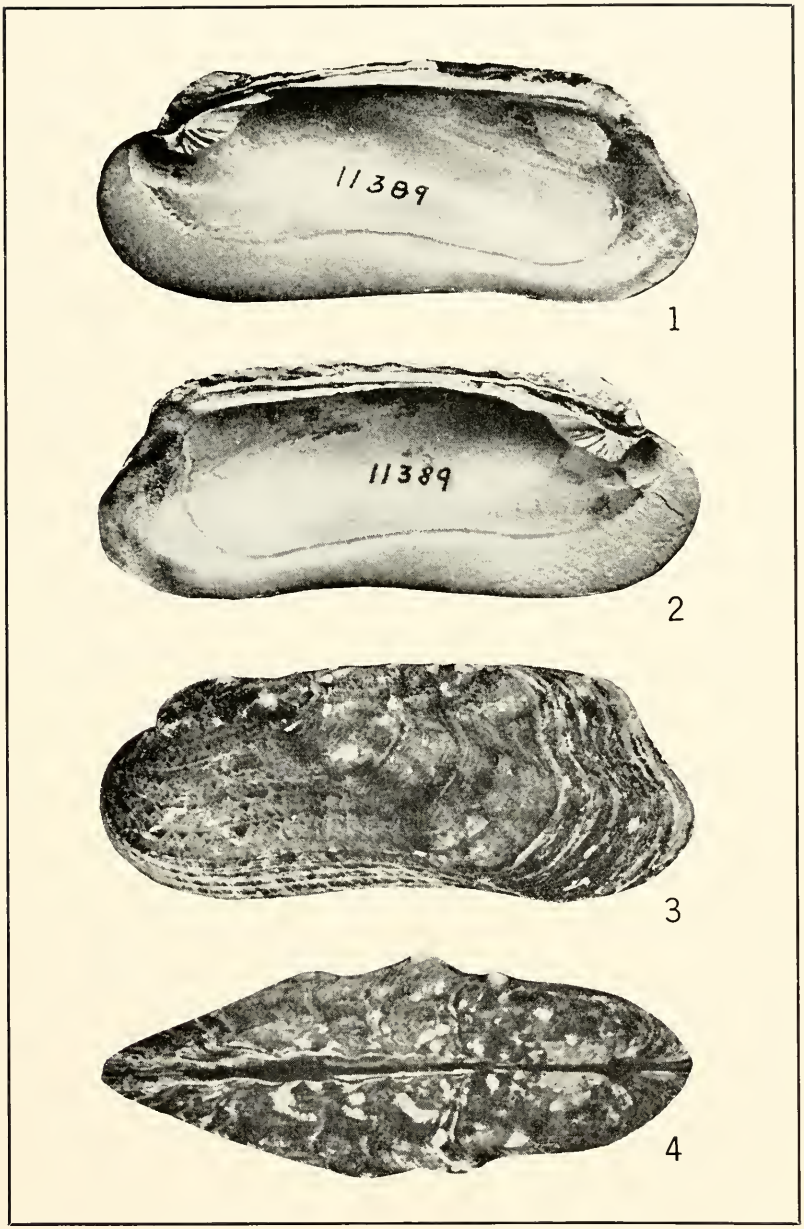
Ecology: This species is found in both large and small rivers where it lives in gravel bottom in deep water, where there is a good current (Baker, 1928, p. 99). In Kansas *Q. metanevra* occurs in quiet pools, on sandy and rocky bottoms, and in water no less than one foot in depth. It does not occur in soft mud bottoms.

Host for Glochidia: The glochidia are found on the gills of *Lepomis macrochirus*, bluegill and *Stizostedion canadense*, sauger.

Remarks: This species is variable in Kansas. The dorsoposterior area may lack pustules, have a few pustules or have numerous plicae. The anterior portion of the shell may lack pustules or have scattered pustules. The color varies from dark brown to dark green, and dark green chevron marks may or may not be present. The shape of the shell varies from rhomboid to circular. The umbonal ridge extending from the umbo to the posteroventral portion of the shell is a distinct and a consistent characteristic of this species.

Owing to the irregular thickness of the shell, it was never valued for buttons. The drying qualities of the shell are excellent, and the interesting shape and color make it desirable for novelties. Scammon (1906, p. 350) reported a specimen 77 mm. (approximately 3⅛ inches) in length from Fall River. There are now several specimens from the Neosho River four inches in length.

PLATE 12



Quadrula cylindrica (Say), no. 11389; from the Spring River, Ravenden, Lawrence Co., Arkansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, left valve; fig. 4, dorsal aspect of shell. Actual length, 4⅛ inches.

Spectacle-Case Mussel

Quadrula cylindrica (Say)

Plate 12, figures 1-4; text figure 8

Unio cylindricus Say, 1817, Nich. Encyc., vol. 2, pl. iv, fig. 3 (no pagination); Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 119.

Quadrula cylindrica, Simpson, 1900, Proc. U. S. Nat. Mus., 22:773; Scammon, 1906, Univ. Kansas Sci. Bull., 3:347; Simpson, 1914, A descriptive catalogue . . . mussels, p. 832.

Type Locality: Wabash River.

General Distribution: "Ohio, Cumberland, and Tennessee river systems; west to Nebraska (Aughey, doubtful); south to Arkansas and Indian Territory [Oklahoma]" (Simpson, 1914, p. 833). Because the known northern limits of the trans-Mississippian distribution of *Quadrula cylindrica* are in southern Missouri and southeastern Kansas, it seems extremely unlikely that the doubtful record from Nebraska is valid.

Occurrence in Kansas: *Q. cylindrica* is restricted to southeastern Kansas. Scammon (1906, p. 348) reports it from the southern drainages of the Neosho, Verdigris, and Spring rivers. Leonard and Franzen collected two isolated valves from the Neosho River in the vicinity of Oswego, Labette County, Kansas in 1943. Failure to find *Q. cylindrica* in the Neosho River since 1955 has not convinced us of its absence in that stream.

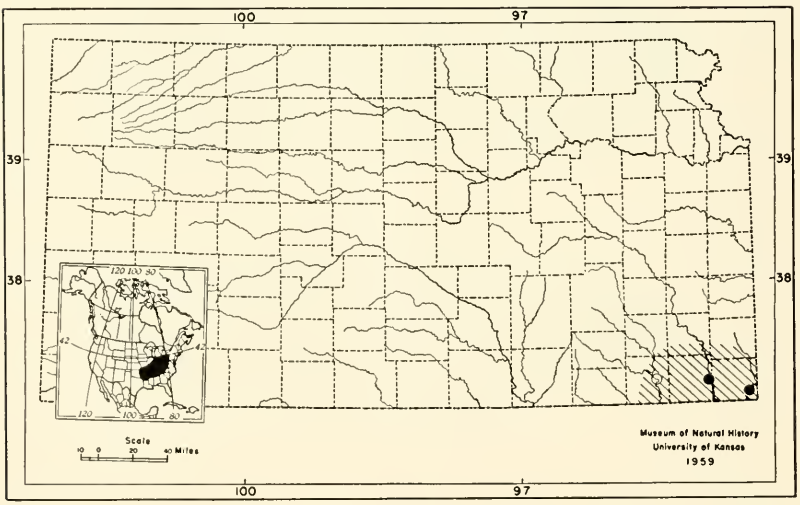


FIG. 8. Distribution of *Quadrula cylindrica* in Kansas. Insert map shows approximate distribution of this species in North America.

The westernmost validated record for *Q. cylindrica* in Kansas is the Neosho River, 3 mi. E Oswego, Labette County (sec. 13 and sec. 24, T. 33 S, R. 21 E, Cherokee County); however, Call (1885, p. 50) reported it from an unspecified locality on the Verdigris River.

Description of Shell: Shell cylindrical, three times as long as high; beaks full and elevated; epidermis straw-colored, having green marks shaped as inverted V's; surface having row of knobs extending over inflated posterior ridge; dorsal ridge having plicae.

Pseudocardinals radially split; laterals long and straight; anterior muscle scars well impressed; posterior muscle scars lightly impressed; beak cavities deep, compressed; nacre silvery white, rarely purple, iridescent and thinner posteriorly.

Ecology: Q. cylindrica is found in swift, clear streams having sandy gravel bars.

Host for Glochidia: Not recorded.

Remarks: The elongate, cylindrical form and the interesting pattern of nodules and marks on the shell make this one of the most beautiful of Kansas unionids. This was never a valuable shell in the manufacture of buttons because of the small size and irregular thickness of the shell.

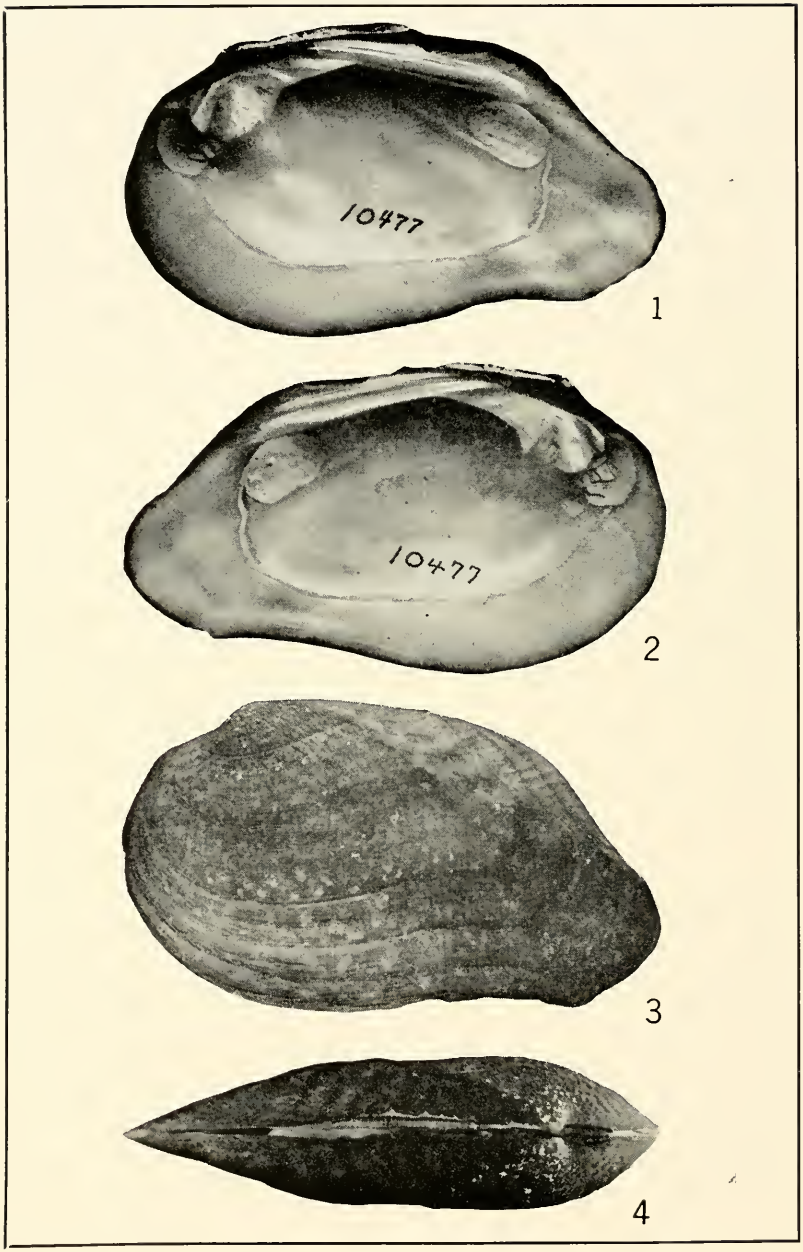
Because most Kansas streams are now highly turbid and pollution is generally increasing, this species is rare and probably is declining.

Because there was no Kansas specimen suitable for illustration, it was necessary to photograph a specimen obtained (in October, 1948, by A. B. Leonard) from the Spring River, Ravenden, Lawrence County, Arkansas (Plate 12, figure 1-4, p. 63).

Genus TRITOGONIA Agassiz 1852

Shell solid, elongate, rhomboid, having strong, irregular posterior ridge, obliquely truncated behind in male, in female somewhat compressed and expanded into broad wing; base curved; whole surface except rounded wing of females having pustules; beaks rather low, incurved and turned forward over well-developed lunule; beak sculpture strong, consisting of irregular, subparallel ridges curving upwards behind; epidermis dark olive; hinge plate rather narrow; pseudocardinals strong, ragged; laterals long and straight, near pseudocardinals; beak cavities rather deep and compressed (after Walker, 1918, p. 45). Type: *Unio tuberculatus* Barnes.

PLATE 13



Tritogonia verrucosa (Barnes), no. 10477, ♂; from Neosho River, at a place 2 mi. W and 2¼ mi. N Emporia, Lyon Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, left valve; fig. 4, dorsal aspect of shell. Actual length, 4¼ inches.

Buckhorn Mussel

Tritogonia verrucosa (Say)

Plate 13, figures 1-4; text figure 9

Unio verrucosus Say, 1834, Am. Conch., 6: (no pagination).

Tritogonia verrucosa, Agassiz, 1852, Arch. für Nat., 1:48; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:388; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Unio tuberculatus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 122; Call, 1886, *op. cit.*, p. 183; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:23.

Tritogonia tuberculata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:313; Clark and Gillette, 1911, Proc. Biol. Soc. Washington, 24:68; Simpson, 1914, A descriptive catalogue . . . mussels, p. 318.

Type Locality: Ohio River.

General Distribution: "Mississippi drainage generally; streams falling into the Gulf of Mexico from the Alabama system west to central Texas" (Simpson, 1914, p. 319).

Occurrence in Kansas: Tritogonia verrucosa is common in the eastern drainages of Kansas. The buckhorn may occur throughout the eastern one-half of the state where suitable habitat is found.

The westernmost records for *T. verrucosa* in Kansas are: Smoky Hill River, Salina, Saline County; Elk River, 1 mi. S and ½ mi. E Howard, Elk County (sec. 12, T. 30 S, R. 10 E).

Description of Shell: Because this is a monotypic genus, the generic description applies to this species.

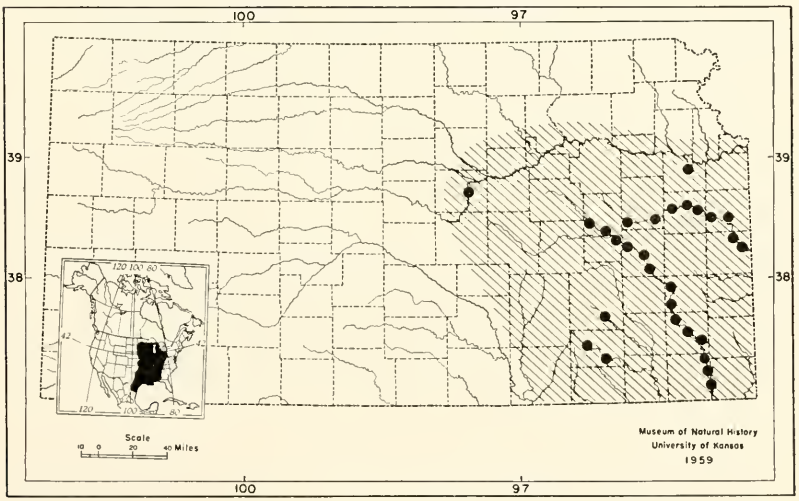


FIG. 9. Distribution of *Tritogonia verrucosa* in Kansas. Insert map shows approximate distribution of this species in North America.

Ecology: The buckhorn is found in almost every stream habitat except bottoms of shifting sand. It occurs in rocky, silty, hard mud and soft mud bottoms, and is common to both large and small streams. Many individuals bury themselves so deeply that only small portions of the posterior parts of the shells project from the substrate.

Host for Glochidia: Not recorded.

Remarks: T. verrucosa has been called the "pistol-grip" shell. This is one of the most unusual Kansas unionids and one of the most easily recognized. The compressed, elongate shell and pustulations distinguish this species from all other Kansas unionids.

There is some variation in the shape and height of the shell, in addition to secondary sexual variations. The epidermis varies from brown to black. The nacre is white in most individuals, but pink in occasional specimens. Large specimens from Kansas range from 5½ to 6 inches in length.

Genus PLETHOBASUS Simpson 1900

Shell large, irregularly oval, inflated, solid, somewhat suddenly swollen at posterior base; posterior ridge low, rounded; beaks rather high, near anterior end, having few strong ridges, curving upwards behind; one row of low, irregular tubercules extending from near beaks to post-basal part of valve; epidermis tawny yellow to dark brown; hinge plate solid, not flattened; pseudocardinals triangular, rough; beak cavities not deep; front part of shell heavy, thinner behind (after Walker, 1918, p. 49). Type: *Unio aesopus* Green.

Bullhead Mussel

Plethobasus cyphyus (Rafinesque)

Plate 14, figures 1-3; text figure 10

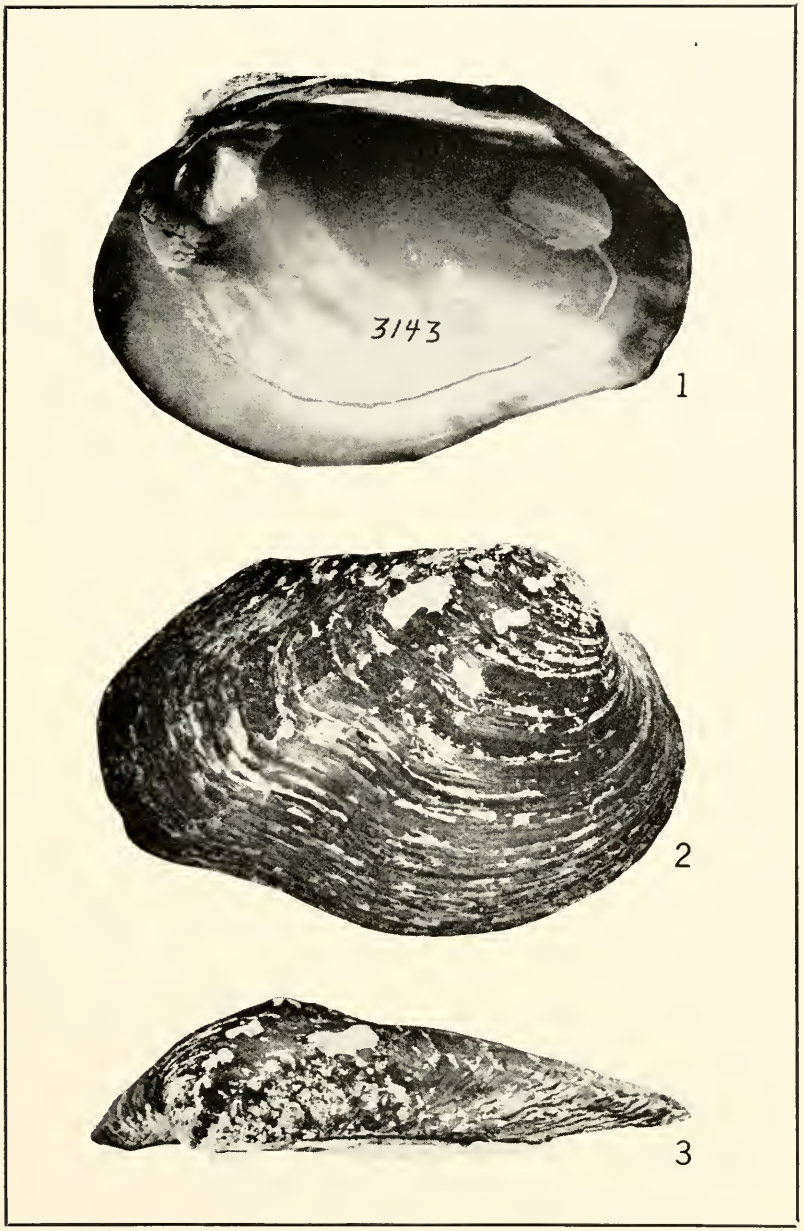
Obliquaria cyphya Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:305.
Plethobasus cyphyus, Ortmann, 1919, Mem. Carnegie Mus., 8:65.
Pleurobema aesopus, Scammon, 1906, Univ. Kansas Sci. Bull., 3:338; Simpson, 1914, A descriptive catalogue . . . mussels, p. 806.

Type Locality: Falls of Ohio, at Louisville, Kentucky.

General Distribution: Mainly in the Ohio, Cumberland and Tennessee river systems; Mississippi River system west to Iowa and Kansas, north to Minnesota.

Occurrence in Kansas: In Kansas *Plethobasus cyphyus* has been recovered only from the Verdigris River, Coffeyville, Montgomery County.

PLATE 14



Plethobasus cyphyus (Rafinesque), no. 3143; from Verdigris River, Montgomery County, Kansas, by R. E. Scammon. Fig. 1, interior, right valve; fig. 2, exterior, right valve; fig. 3, dorsal aspect of right valve. Actual length, 4⅞ inches.

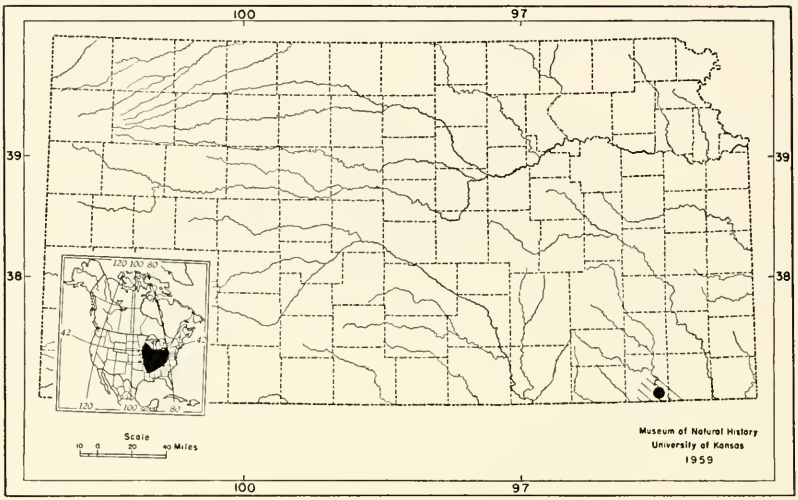


FIG. 10. Distribution of *Plethobasus cyphyus* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell elongated ovate, inflated, solid, oblique; anterior end acutely rounded; posterior end long, pointed; ventral margin rounded anteriorly, having a straight or slightly incurved margin posterior to a swelling midway of the margin caused by a thick rib extending toward the ventral margin in an oblique direction; usually a row of large tubercular swellings on center of valve extending down rib from near umbones to ventral margin; beaks rather full, high, placed near anterior margin; wide radial depression behind row of tubercules; epidermis yellowish or brownish, rest period darker; no rays.

Two large, more or less triangular, divergent, sulcated pseudocardinals in left valve; one large triangular, sulcated pseudocardinal in right valve, usually having small denticle on either side; interdentum narrow; laterals heavy, sulcated, usually double in right valve; beak cavity shallow; nacre pearly white, slightly iridescent posteriorly (after Baker, 1928, p. 110).

Ecology: Baker (1928, p. 112) reports that *P. cyphyus* inhabits large rivers with swift current having sand, mud, and gravel bottoms. There are no data available concerning the conditions under which specimens in Kansas were obtained; however, the Verdigris River, except for its smaller size, would meet these requirements.

Host for Glochidia: The glochidia occur on the gills of *Stizostedion canadense*, the sauger (Baker, 1928, p. 112).

Remarks: There are only three specimens of *P. cyphyus* known from Kansas; all were obtained near Coffeyville, Montgomery County, Kansas. Of the three specimens there is only a half shell remaining. Because it has never been recorded elsewhere in the state and because no specimens have been recovered since 1909, its present occurrence in Kansas is doubted. The Verdigris River, especially the lower portion, has not been carefully investigated. It may be restricted to Montgomery County.

Because of its extremely hard nacre, *P. cyphyus* was not valued for buttons. One of the specimens reported by Scammon (1906, p. 339) measured approximately 5 inches in length.

Genus Pleurobema Rafinesque 1820

Shell solid, triangular to rhomboid, usually having prominent umbonal region; beaks at or near anterior end, incurved, pointed forward over small, well-developed lunule; beak sculpture coarse, of a few, often broken, ridges curving upward posteriorly; posterior ridge present, low, rounded; epidermis showing rest periods plainly, tawny to olive, often having rays showing tendency to break into square spots; hinge plate rather strong, generally narrow; pseudocardinals double in both valves (after Walker, 1918, p. 50). Type: *Unio clava* Lamarck.

Round Pig-Toed Mussel

Pleurobema cordatum coccineum (Conrad)

Plate 15, figures 1-3; text figure 11

Unio coccineus Conrad, 1836, Monog. 3:29, pl. 13, fig. 1; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 119; Call, 1886, *op. cit.*, p. 180; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:20.

Pleurobema cordatum coccineum, Goodrich and van der Schalie, 1944, Amer. Midl. Nat., 32(2):309.

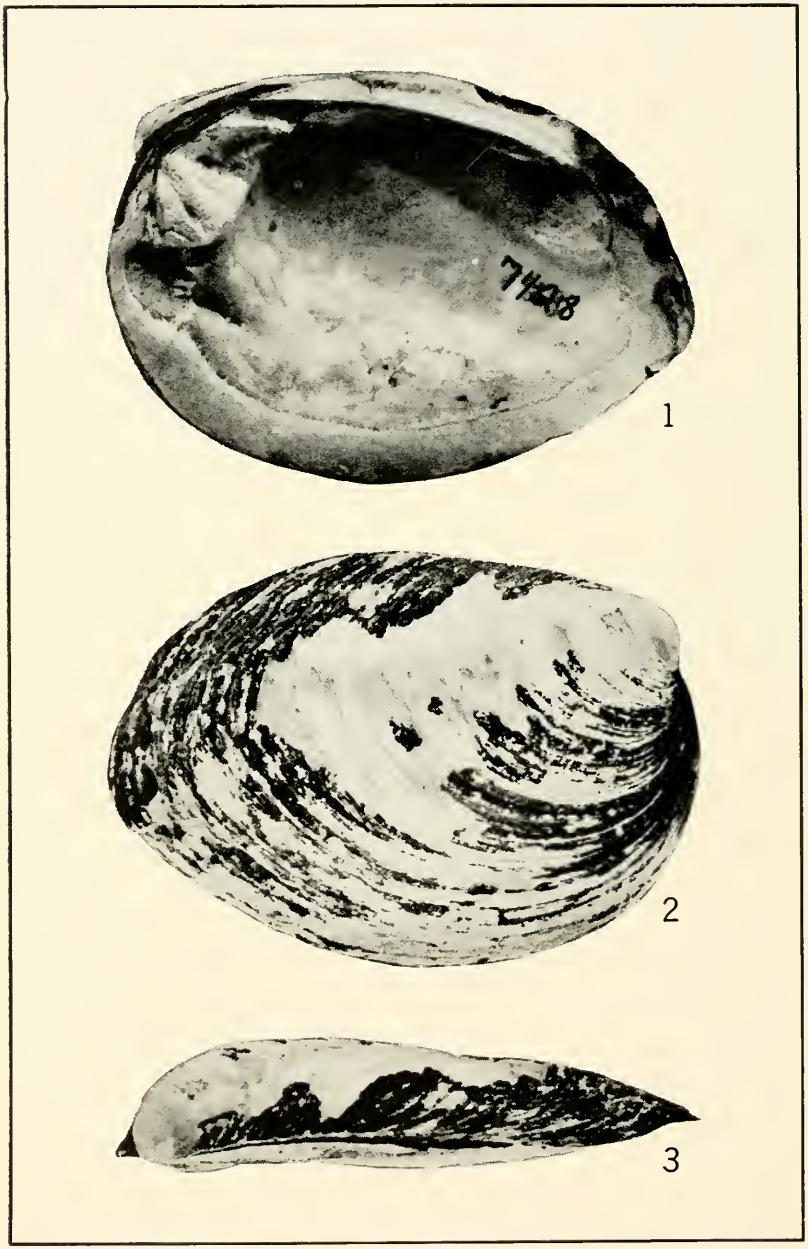
Quadrula coccinea, Scammon, 1906, Univ. Kansas Sci. Bull., 3:361; Simpson, 1914, A descriptive catalogue . . . mussels, p. 883.

Type Locality: Mahoning River, near Pittsburgh, Pennsylvania.

General Distribution: Upper portion of the Mississippi River drainage from extreme southwestern New York west to Kansas and Iowa, north to upper Wisconsin, and south to Alabama; St. Lawrence River drainage.

Occurrence in Kansas: In Kansas *Pleurobema cordatum coccineum* is restricted to the Marais des Cygnes and Verdigris river drainages. It may occur in the headwaters of the Neosho River, and probably is restricted to smaller streams.

PLATE 15



Pleurobema cordatum coccineum (Conrad), no. 7428; from Elk River, 1 mi. S Howard, Elk Co., Kansas. Fig. 1, interior, right valve; fig. 2, exterior, right valve; fig. 3, dorsal aspect of right valve. Actual length, 3¼ inches.

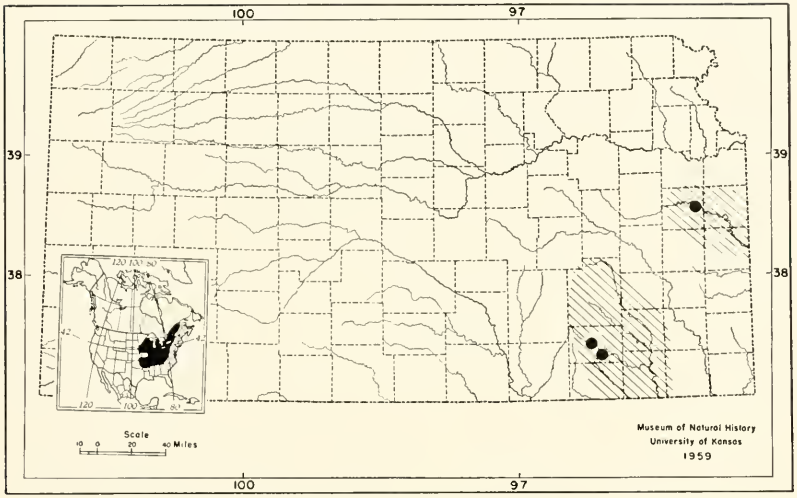


FIG. 11. Distribution of *Pleurobema cordatum coccineum* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

The westernmost record for *P. c. coccineum* is 1 mi. S Howard, Elk County (sec. 12, T. 30 S, R. 10 E).

Description of Shell: Shell flattened laterally, compressed, solid, subquadrangular; beaks slightly elevated, compressed, turned forward over lunule; beak sculpture of a few coarse, irregular ridges, curving upward behind; anterior end well rounded, slightly truncated above at junction of dorsal margin; posterior end squarely truncated; posterior ridge rounded, ending below in rounded point; slight depression above posterior ridge; surface roughened by only growth lines; epidermis yellowish-brown or chestnut, often pinkish, faintly rayed in young specimens; no sexual dimorphism in shape of shell.

Pseudocardinals rather heavy, triangular, divergent, coarsely radially sulcated, two in left valve forming inverted V; single large, triangular, sulcated pseudocardinal in right valve, having two accessory denticles near hinge line; interdentum wide, flat; laterals short, straight or slightly curved, thick, solid, wide; muscle scars and pallial line well impressed; cavity of beaks shallow, compressed; nacre white or pinkish, more or less iridescent (after Baker, 1928, p. 113).

Ecology: Typically *P. c. coccineum* inhabits small streams and creeks. In Kansas there are valid records only from the upper Elk and upper Marais des Cygnes rivers, both classified as small streams.

Host for Glochidia: Not recorded.

Remarks: Among Kansas unionids, *P. c. coccineum* may be most easily confused with *Fusconaia flava.* It may be distinguished from the latter by the more anteriorly placed umbones, the more shallow beak cavity, and the somewhat more elongate shell. Because of its elongate form, *P. c. coccineum* is readily distinguished from the other two subspecies in Kansas, *P. c. catillus* and *P. c. pyramidatum.*

Because *P. c. coccineum* occurs in the headwaters of the Marais des Cygnes River and because Utterback (1916a) found *P. c. catillus* in the Osage River (Marais des Cygnes), it is judged that intergradation between *coccineum* and *catillus* occurs somewhere in the lower portions of the Marais des Cygnes River in Kansas. The relationships among *P. c. coccineum, P. c. catillus,* and *P. c. pyramidatum* in southern Kansas are not clear.

The three half-shells of this species in our collection indicate the rarity of *P. c. coccineum* in Kansas and the incompleteness of the record. Large specimens from Kansas range from 3 to 3½ inches in length.

Solid Pig-Toed Mussel

Pleurobema cordatum catillus (Conrad)

Plate 16, figures 1-4; text figure 12

Unio catillus Conrad, 1836, Monog. 3:30, pl. 13, fig. 2.

Pleurobema cordatum catillus, Goodrich and van der Schalie, 1944, Amer. Midl. Nat., 32(2):309.

Quadrula solida, Scammon, 1906, Univ. Kansas Sci. Bull., 3:362; Simpson, 1914, A descriptive catalogue . . . mussels, p. 885.

Unio solidus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:94; Call, 1886, *op. cit.,* p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:23.

Type Locality: Scioto River, Ohio.

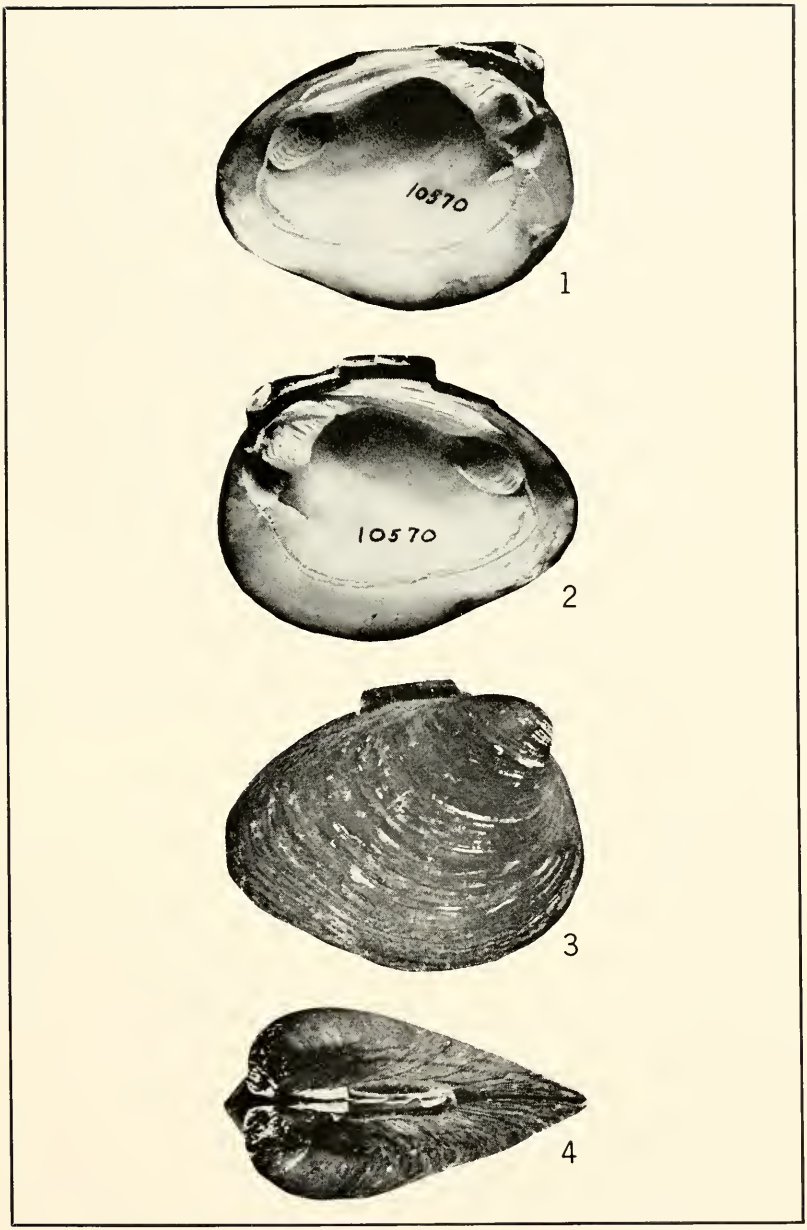
General Distribution: Primarily in the upper Mississippi River drainages from extreme southwestern New York west to Kansas, south to Arkansas and north to upper Wisconsin.

Occurrence in Kansas: Pleurobema cordatum catillus is known from two localities in the southern part of the Neosho River where it is rare.

The westernmost record for *P. c. catillus* in Kansas is 2½ mi. S and 1¾ mi. W Iola, Allen County (sec. 9, T. 25 S, R. 18 E).

Description of Shell: Differing from *P. c. coccineum* in being shorter, more rounded in outline; anterior end more rounded; posterior end more pointed ventrally; whole shell more inflated, having higher umbones directed further forward; anterior dorsal

PLATE 16



Pleurobema cordatum catillus (Conrad), no. 10570; from Neosho River, 2½ mi. S and 1¾ mi. W Iola, Allen Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 3¼ inches.

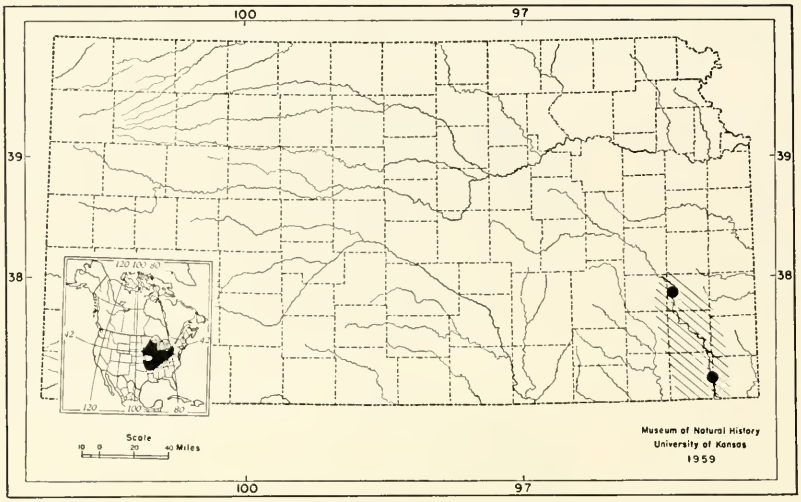


FIG. 12. Distribution of *Pleurobema cordatum catillus* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

margin in front of umbones shorter and rounder; interdentum wider; pseudocardinals more massive; laterals shorter, thicker and curved more directly downward to base of shell; whole shell more oblique than *coccineum* (after Baker, 1928, p. 117).

Ecology: *P. c. catillus* typically inhabits streams of medium size in sand, gravel, or mud bottoms.

Host for Glochidia: Not recorded.

Remarks: In Kansas *P. c. catillus* may be confused with the subspecies *pyramidatum*. The difference between these two subspecies are discussed under *P. c. pyramidatum*.

Large specimens from Kansas range from 3 to 3¼ inches in length.

Pyramid Pig-Toed Mussel

Pleurobema cordatum pyramidatum (Lea)

Plate 17, figures 1-4; text figure 13

Unio pyramidatus Lea, 1834, Trans. Amer. Phil. Soc., 4:109, pl. 16, fig. 39; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:94.

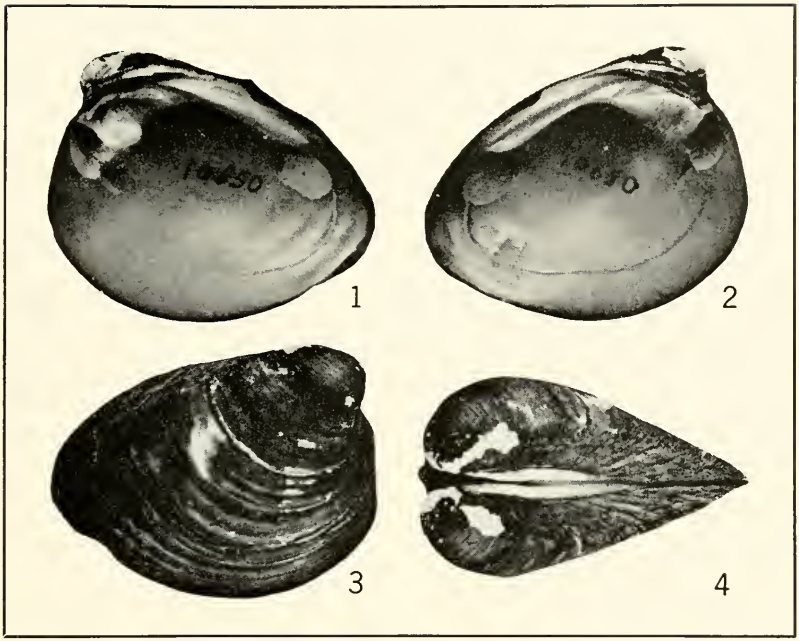
Pleurobema cordatum pyramidatum, Goodrich and van der Schalie, 1944, Amer. Midl. Nat., 32(2):309.

Quadrula pyramidata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:365; Simpson, 1914, A descriptive catalogue . . . mussels, p. 888.

Unio plenus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:116.

Type Locality: Ohio.

PLATE 17



Pleurobema cordatum pyramidatum (Lea), no. 10650; from Neosho River, 1½ mi. E Oswego, Labette Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 2½ inches.

General Distribution: Upper Mississippi River drainage from western Pennsylvania west to Kansas and Nebraska, south to Arkansas, and north to upper Wisconsin.

Occurrence in Kansas: Pleurobema cordatum pyramidatum is known only from the Neosho River in Kansas. It has not been recorded north of Emporia on the Neosho River nor west of Emporia on the Cottonwood River.

Description of Shell: Differing from *P. c. catillus* in being more inflated, having higher and more inflated umbones; shell squarish or roundly oblique; anterior end rounded; posterior end squarely truncated; in some individuals indication of radial furrow in front of posterior ridge; young shells rayed, adult shells sometimes rayed on umbones; hinge more massive than *catillus;* interdentum wider; pseudocardinals more massive and ragged; laterals shorter, wider, more massive, slightly curved or straight, more directly bent toward

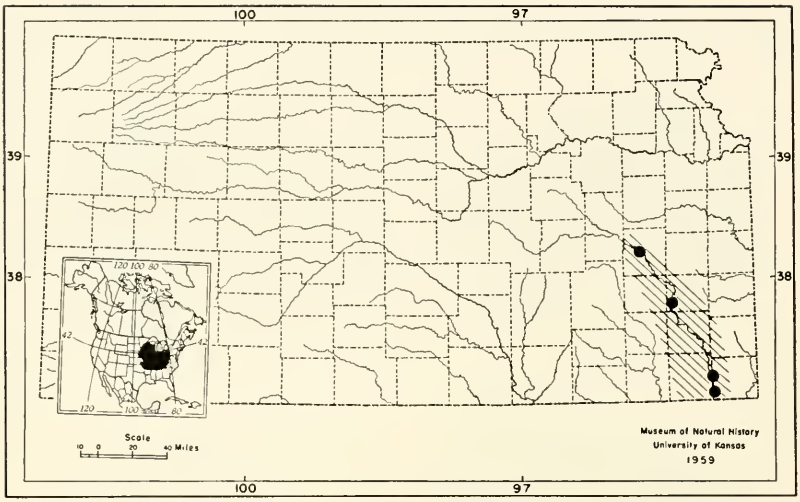


FIG. 13. Distribution of *Pleurobema cordatum pyramidatum* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

base of shell than *catillus;* whole shell massive and heavy (after Baker, 1928, p. 119).

Ecology: P. c. pyramidatum inhabits streams of medium size and is usually found in deep water in sand or gravel bottoms (Baker, 1928, p. 120).

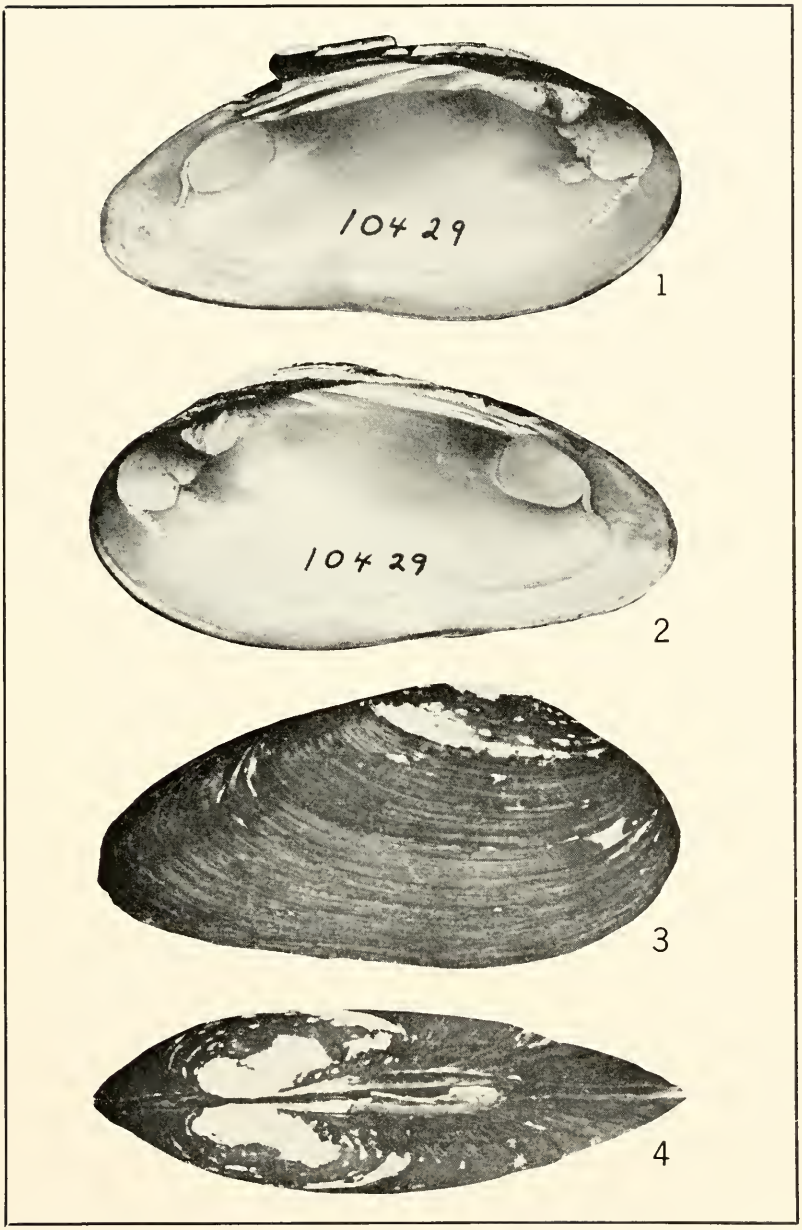
Host for Glochidia: The glochidia have been observed on the gills of the sunfish, *Lepomis macrochirus* (Surber, 1913, p. 113).

Remarks: Additional data are necessary in order to understand the intergradation of the three subspecies of *P. cordatum* in Kansas, if indeed such intergradation occurs within the state. Large specimens of *P. c. pyramidatum* from Kansas range from 3 to 3½ inches in length.

Genus ELLIPTIO Rafinesque 1819

Shell inequilateral, ovate to elongate, rounded in front, pointed or biangulate behind; posterior ridge more or less developed becoming slightly arcuate in old examples; beaks moderately full, generally sculptured having coarse ridges, parallel to growth lines or somewhat doubly looped; surface smooth; slightly concentrically ridged or pustulose; epidermis rather dull, rayless, or fully rayed; hinge plate narrow; two pseudocardinals, two laterals in left valve; one pseudocardinal, one lateral in right valve, rarely vestige of second lateral; cavity of beaks not deep or compressed (after Walker, 1918, p. 51). Type: *Unio crassidens* Lamarck.

PLATE 18



Elliptio dilatatus (Rafinesque), no. 10429; from Marais des Cygnes River, at a place 4½ mi. W and 2 mi. N Osawatomie, Miami Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4 inches.

Lady-Finger Mussel

Elliptio dilatatus (Rafinesque)

Plate 18, figures 1-4; text figure 14

Unio dilatata Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:297.

Elliptio dilatatus, Utterback, 1916, Amer. Midl. Nat., 4:40.

Unio gibbosus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:94; Call, 1885, *op. cit.*, p. 120; Call, 1886, *op. cit.*, p. 181; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21; Scammon, 1906, Univ. Kansas Sci. Bull., 3:334; Simpson, 1914, A descriptive catalogue . . . mussels, p. 597.

Type Locality: Ohio River.

General Distribution: Entire Mississippi River drainage north to Minnesota and Wisconsin, south to Louisiana, east to western Pennsylvania, and west to Guadalupe River, Texas; Alabama River system east to southeastern Florida; St. Lawrence River and tributaries (Baker, 1928, p. 126; La Rocque, 1953, p. 91).

Occurrence in Kansas: Elliptio dilatatus is restricted to the streams of eastern Kansas. Scammon (1906, p. 335) obtained a single valve from the Wakarusa River near Lawrence, Kansas, but Franzen and Leonard (1943) did not report this species from the same river. It seems unlikely that it ranges north of the Marais des Cygnes River drainage in Kansas.

The westernmost record for *E. dilatatus* in Kansas is the Neosho River, 2½ mi. W Americus, Lyon County (sec. 9, T. 18 S, R. 10 E).

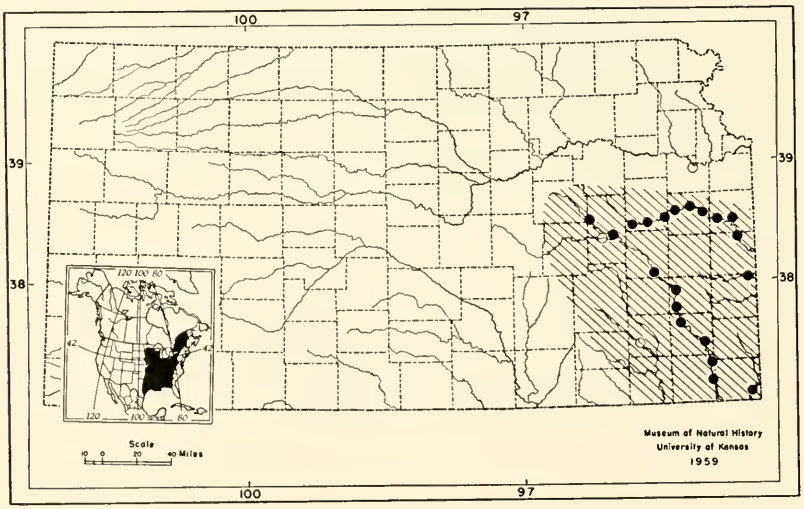


FIG. 14. Distribution of *Elliptio dilatatus* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell elongated, heavy, thick, usually compressed, may be slightly inflated, markedly inequipartite; beaks depressed, flattened, turned slightly forward over conspicuous lunule; beak sculpture of 4-5 well developed bars, running parallel to growth lines; anterior end broadly rounded; posterior end sharply pointed, often compressed; ventral margin broadly convex in young shells, straight or arcuate in older shells; dorsal margin slightly curved, descending abruptly posteriorly, ending in sharp biangulation; posterior ridge strongly developed, more or less angular; surface roughened by concentric growth lines, more or less even; epidermis black or brown in old specimens, greenish or yellowish green in young specimens, often slightly rayed.

Pseudocardinals of both valves triangular, compressed, sulcated; right valve having two additional cusps above pseudocardinals; lateral heavy, wide, rough; interdentum moderately wide, smooth; beak cavities shallow, often not evident; dorsal scars distinct; adductor scars impressed at both ends of shell; pallial line impressed; nacre varying from white, through salmon, to deep purple, iridescent posteriorly (after Baker, 1928, p. 125).

Ecology: E. dilatatus has been collected in a wide range of habitats in Kansas: soft, deep mud; sand and mud; rock and sand; rock and mud. It is not recorded from areas having shifting sand bottoms.

Host for Glochidia: Not recorded.

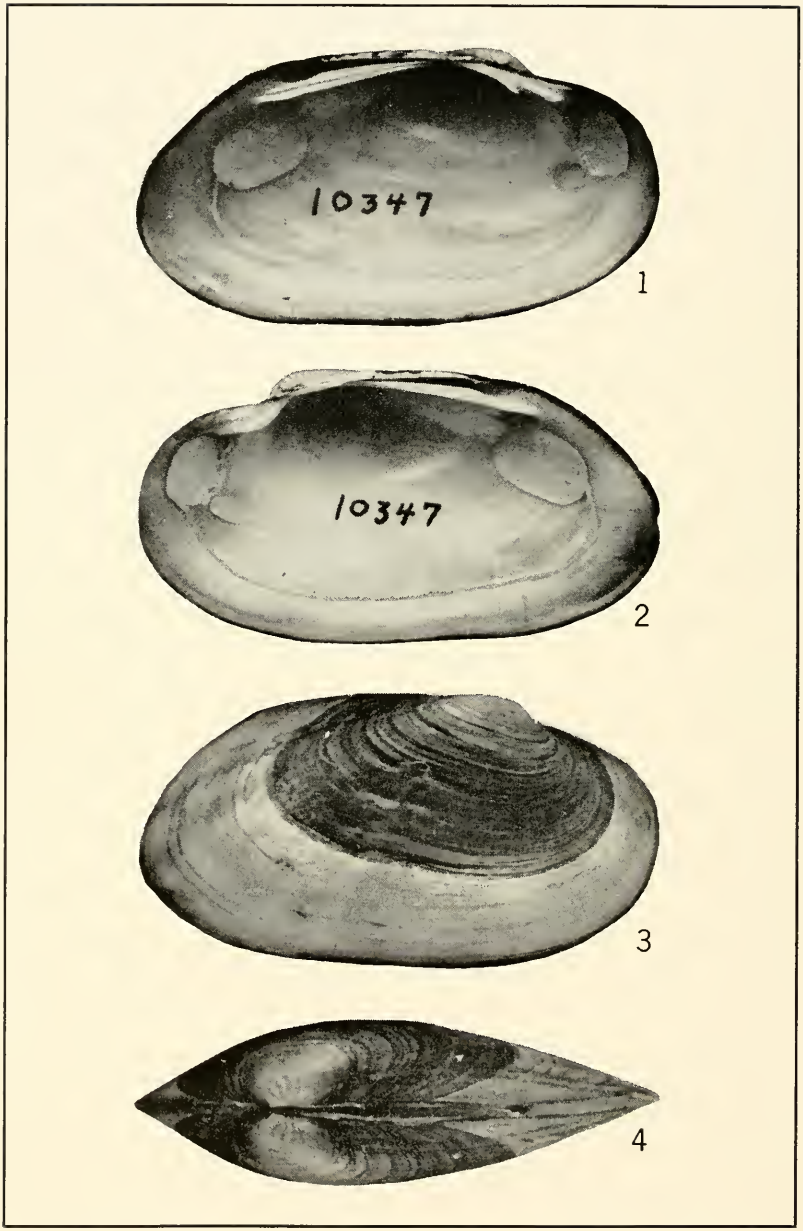
Remarks: E. dilatatus may be confused with *Ligumia recta latissima.* The differences are discussed under *L. r. latissima.*

The nacre of this species is one of the most beautiful of Kansas unionids. The nacre is rarely discolored and may vary from a deep, rich, dark, purple to salmon and white. The shell is valued for novelties and mother-of-pearl. It was not valued for buttons. Large specimens from Kansas range from 5 to 5½ inches in length.

Genus Uniomerus Conrad 1853

Shell trapezoid, having rounded posterior ridge; pointed posteriorly or feebly biangulate; beaks not prominent; beak having 10-15 curved, rather strong, concentric ridges, drawing upward and close together behind; epidermis generally rayless, often clothlike; pseudocardinals usually compressed; laterals delicate, slightly curved; muscle scars large, shallow; nacre generally yellowish (after Simpson, 1914, p. 704). Type: *Unio tetralasmus* Say.

PLATE 19



Uniomerus tetralasmus (Say), no. 10347; from Delaware River, a place 8 mi. W and 3½ mi. W Horton, Brown Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 2⅝ inches.

Pond-Horn Mussel

Uniomerus tetralasmus (Say)

Plate 19, figures 1-4; text figure 15

Unio tetralasmus Say, 1830, Amer. Conch., III, pl. 23.

Uniomerus tetralasmus, Ortmann, 1912, Ann. Carnegie Mus., 8:272; Leonard, 1943, Trans. Kansas Acad. Sci., 46:231; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:394; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Unio tetralasmus, Scammon, 1906, Univ. Kansas Sci. Bull., 3:336; Simpson, 1914, A descriptive catalogue . . . mussels, p. 705.

Unio camptodon, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.,* p. 96; Call, 1885, *op. cit.,* p. 119; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19.

Type Locality: Bayou St. John, New Orleans, Louisiana.

General Distribution: Mississippi River drainages from Iowa and Indiana south to Louisiana, east to western Tennessee, and west to Colorado, western Oklahoma, and the Staked Plains of Texas.

Occurrence in Kansas: Uniomerus tetralasmus is widely distributed in Kansas, exceeded only by *Anodonta grandis. U. tetralasmus* occurs over entire eastern one-half of state and entire southwestern portion as well.

The westernmost records for *U. tetralasmus* in Kansas are: Solomon River, Minneapolis, Ottawa County (specimen not seen); "The Lake," Garden City, Finney County (specimen not seen); Crooked Creek, ½ mi. W Fowler, Meade County (sec. 1, T. 31 S, R. 26 W).

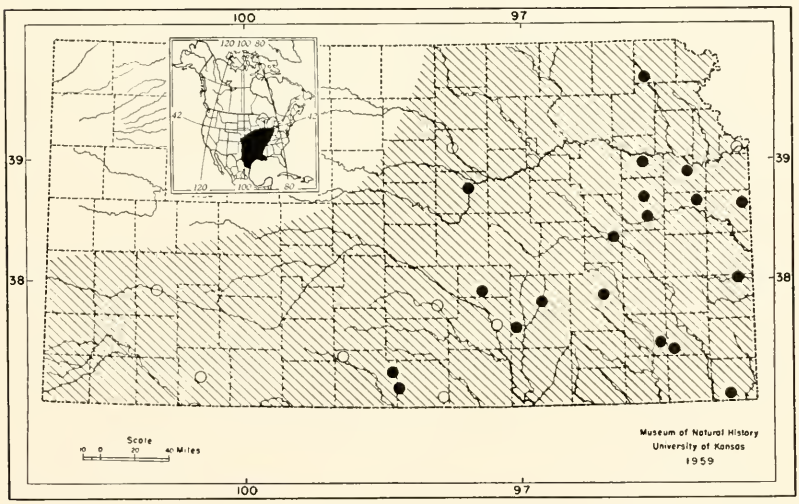


FIG. 15. Distribution of *Uniomerus tetralasmus* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell elongated, thin to subsolid, convex to subinflated, inequilateral; beaks somewhat full, elevated; dorsal and ventral lines nearly parallel; beak sculpture consisting of 6-7 moderately concentric ridges rounded up sharply behind; posterior ridge widely rounded, ending behind in point just below median line; usually two radiating furrows on dorsal slope; anterior end evenly rounded; surface having feeble, concentric sulcations; epidermis yellowish-brown or ashy-brown, banded with lighter color, rather smooth, often subshining.

Two subcompressed pseudocardinals in each valve, upper of right valve small; laterals long, two in left valve, one in right valve; beak cavity moderately deep; dorsal scars immediately under beaks; muscle scars smooth, shallow; nacre white (after Simpson, 1914, p. 705).

Ecology: U. tetralasmus is most frequently found in ponds, lakes, and small quiet streams (Utterback, 1916a, p. 95). In Kansas it occurs in habitats of soft or hard mud bottoms in shallow water.

Host for Glochidia: Not recorded.

Remarks: In Kansas *U. tetralasmus* may be confused with *Ligumia subrostrata* and certain immature members of the genus *Lampsilis*. The concentric ridges, which turn sharply upward at the posterior edge of the umbo, will distinguish *U. tetralasmus* from all other Kansas unionids.

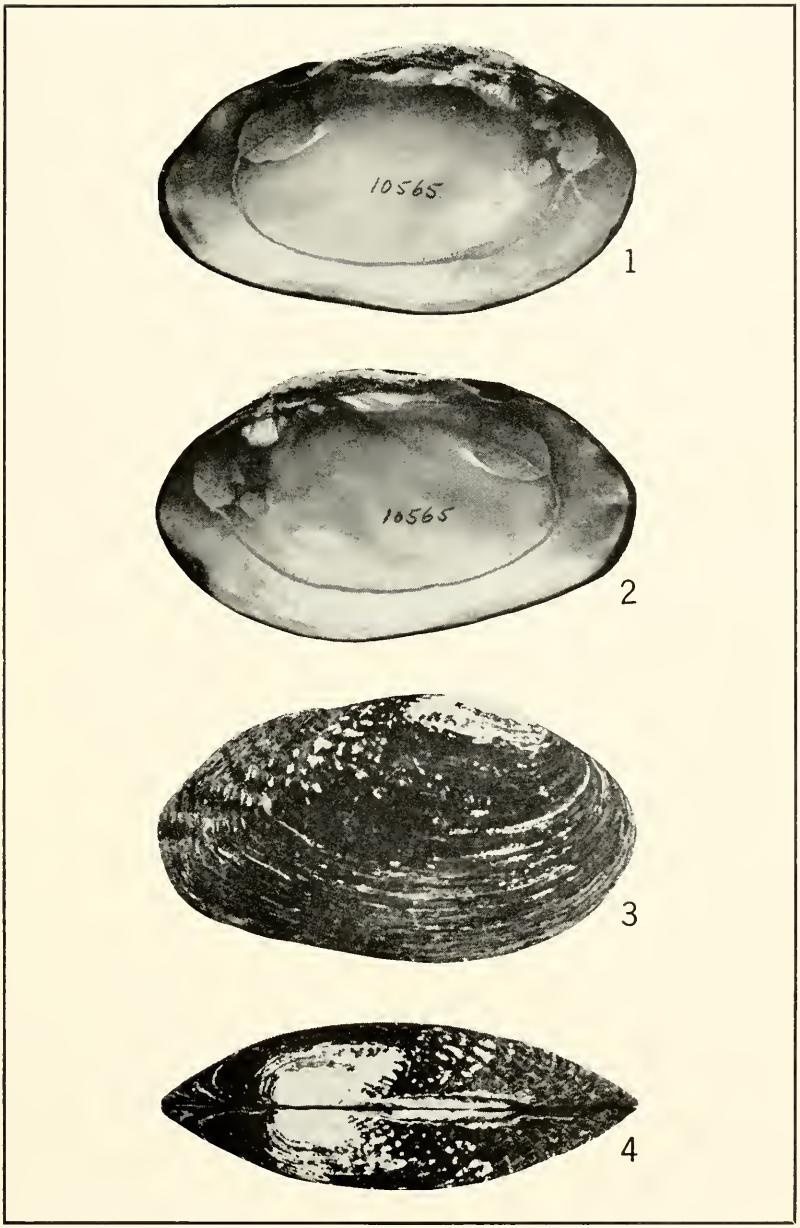
U. tetralasmus is not valued for buttons; however, its beautiful nacre and the interesting brown and yellow epidermis of some specimens make this a desirable novelty. Although it is primarily found in small, quiet streams and ponds, it can be expected in larger streams having quiet, pondlike areas. Large specimens from Kansas range from 4 to 4½ inches in length.

SUBFAMILY Anodontinae

Genus Lasmigona Rafinesque 1831

Shell elliptic-rhomboid, compressed; beaks low, sculptured by having strong bars; one pseudocardinal in right valve; two pseudocardinals in left valve, posterior one somewhat A-shaped, cutting off hinge plate in right valve; laterals generally imperfect (after Walker, 1918, p. 39). Type: *Alasmidonta costata* Rafinesque.

PLATE 20



Lasmigona costata (Rafinesque), no. 10565; from Neosho River, at a place 2½ mi. S and 1¾ mi. W Iola, Allen Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4⅞ inches.

Fluted Mussel

Lasmigona costata (Rafinesque)

Plate 20, figures 1-4; text figure 16

Alasmidonta costata Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:318, pl. 82, figs. 15, 16.

Lasmigona costata, Rafinesque, 1831, Mono. Bivalves Ohio River, pp. 1-5.

Margaritana rugosa, Call, 1886, Bull. Washburn College Lab. Nat. Hist., 1:180; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19.

Symphynota costata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:331; Simpson, 1914, a descriptive catalogue . . . mussels, p. 488.

Type Locality: Kentucky River.

General Distribution: Entire Mississippi drainage from western New York west to western Iowa and eastern Kansas, Oklahoma, and Texas, from southern Wisconsin and Minnesota south to Louisiana and Alabama; St. Lawrence river basin; Manitoba, Canada (Baker, 1928 and La Rocque, 1953).

Occurrence in Kansas: In Kansas the fluted mussel is known only from the Neosho River; however, it may occur in the Verdigris River drainage. It is extremely rare in Kansas.

The westernmost records for *Lasmigona costata* in Kansas are: Neosho River, Emporia, Lyon County (specimen not seen); Neosho River, 2½ mi. S and 1¾ mi. W Iola, Allen County (sec. 9, T. 25 S, R. 18 E).

Description of Shell: Shell subrhomboid, more or less compressed, solid but not heavy; anterior end somewhat acutely rounded; pos-

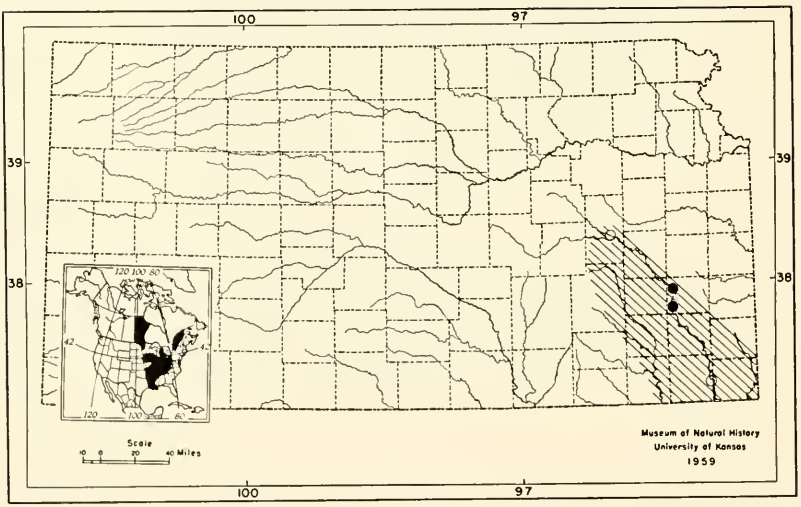


FIG. 16. Distribution of *Lasmigona costata* in Kansas. Insert map shows approximate distribution of this species in North America.

terior end obliquely truncated, biangulate at lower part; ventral margin straight or slightly convex, may be concave in older specimens; height behind umbones greater than height in front of umbones; posterior ridge usually well developed, rounded; beaks depressed, scarcely rising above level of dorsal margin; beak sculpture of 3-4 heavy bars; surface sculpture of coarse lines, rest periods marked by heavy, raised, concentric, black-edged ridges; dorsoposterior margin marked by corrugations or flutings, usually turned upwards; epidermis yellowish, younger shells having grass-green rays, older shells horny, yellowish, brownish to black; very old shells black, rayless.

One fused, heavy, elevated, corrugated pseudocardinal in left valve; one heavy, elevated, corrugated pseudocardinal in right valve; laterals only rudimentary thickenings on hinge line; interdentum narrow or absent; muscle scars and pallial line well marked; beak cavity shallow; nacre white, cream-colored or salmon; posteroventral border of nacre may be violet (after Baker, 1928, p. 142).

Ecology: "Prefers gravel on riffles, but also found in sand and fine gravel in quiet waters" (Baker, 1928, p. 143). This type of habitat is duplicated many times in Kansas; however, *L. costata* is rare. The high turbidity of Kansas streams may be an important factor in limiting its distribution and numbers in Kansas.

Host for Glochidia: Artificial infections of glochidia have been made upon carp and other fishes (Lefevre and Curtis, 1912, p. 138).

Remarks: Because of its thin shell, *L. costata* was not valued for buttons. The elongate shell and rugose dorsoposterior areas distinguish *L. costata* from other Kansas unionids. Large specimens from Kansas range from 5 to 5½ inches in length.

White Heel-Splitter Mussel

Lasmigona complanata (Barnes)

Plate 21, figures 1-4; text figure 17

Alasmidonta complanata Barnes, 1823, Amer. Jour. Sci., 6:278, pl. 13, fig. 21.

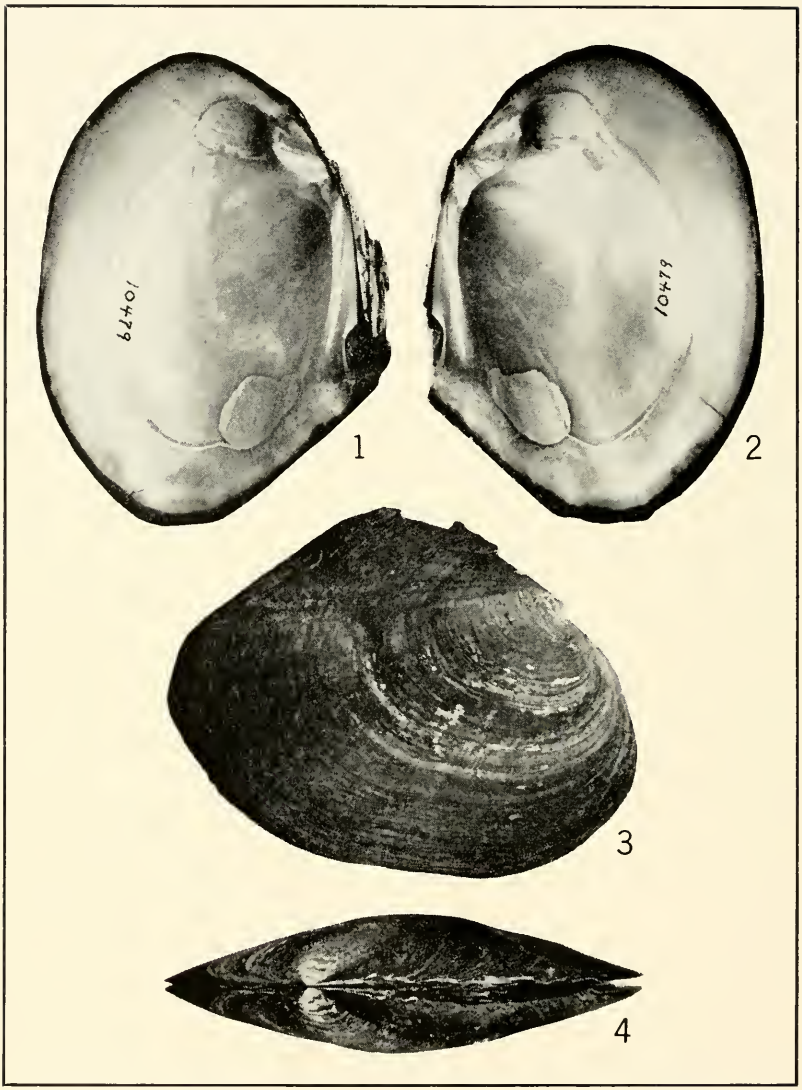
Lasmigona complanata, Ortmann, 1919, Mem. Carnegie Mus., 8:133; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:392; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Margaritana complanata, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:51; Call, 1885, *op. cit.,* p. 96; Call, 1885, *op. cit.,* p. 122; Call, 1886, *op. cit.,* p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19.

Symphynota complanata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:332; Clark and Gillette, 1911, Proc. Biol. Soc. Washington, 24:67; Simpson, 1914, A descriptive catalogue . . . mussels, p. 490.

Type Locality: Fox River, Wisconsin.

PLATE 21



Lasmigona complanata (Barnes), no. 10479; from Neosho River, at a place 2 mi. W and 2¼ mi. N Emporia, Lyon Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 5½ inches.

General Distribution: Entire Mississippi River drainage north of the Arkansas River; Hudson Bay drainage; upper St. Lawrence River and its tributaries north to the Mackenzie River.

Occurrence in Kansas: The "white heel-splitter" is common in the drainages of southeastern Kansas and may occur throughout the eastern one-half of Kansas, except north of the Kansas River.

The westernmost records for *Lasmigona complanata* in Kansas are: Solomon River, Minneapolis, Ottawa County (specimen not seen); Smoky Hill River, Salina, Saline County (specimen not seen); Little Arkansas River, Wichita, Sedgwick County (specimen not seen).

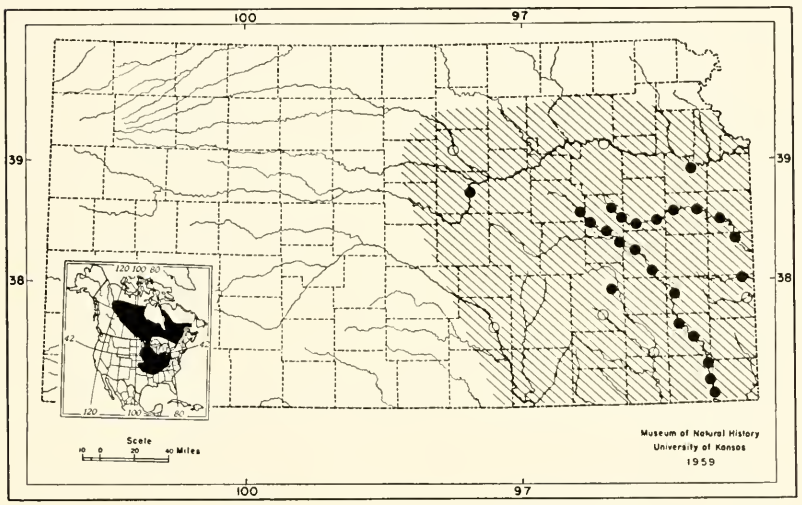


FIG. 17. Distribution of *Lasmigona complanata* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell large, solid as adult, thin as young, broadly ovate, subrhomboid or irregularly elliptical in outline, almost as high as long; anterior end rounded; posterior end obliquely truncated, biangulate at lower margin; ventral margin rounded; dorsal margin straight, ascending posteriorly to form distinct wing; posterior ridge flatly rounded; beaks depressed, not elevated above dorsal margin; beak sculpture of 4-5 heavy bars, first two simple, others strongly doubly looped; sculpture of shell of coarse lines, elevated at rest periods; posterior slope sometimes having irregular ridges, extending to posterior margin; epidermis yellowish or brown-

ish in young shells, indistinctly rayed, older shells brownish to blackish; shell of female slightly swollen in post-basal region.

One massive, fan-shaped pseudocardinal in right valve; two irregular massive, pseudocardinals in left valve; all teeth cut into hinge plate of opposing shell; laterals absent or as small lamellar thickenings on hinge line; interdentum narrow; anterior muscle scars well marked; posterior scars faint; beak cavities shallow having dorsal muscle scars; nacre white, iridescent, sometimes pinkish or cream colored near anterior end and in beak cavity (after Baker, 1928, p. 148).

Ecology: *L. complanata* is found in both large and small streams. It is usually buried deeply in soft mud, but may inhabit rocky stretches. In streams characterized by swift current, *L. complanata* is usually found in quiet pondlike areas.

Host for Glochidia: Not recorded.

Remarks: In Kansas *L. complanata* can be confused only with *Proptera alata*. The former is more compressed, has sculptured umbones, and has white nacre; *P. alata* is more inflated, lacks any sculpture on the umbones, and has purple nacre.

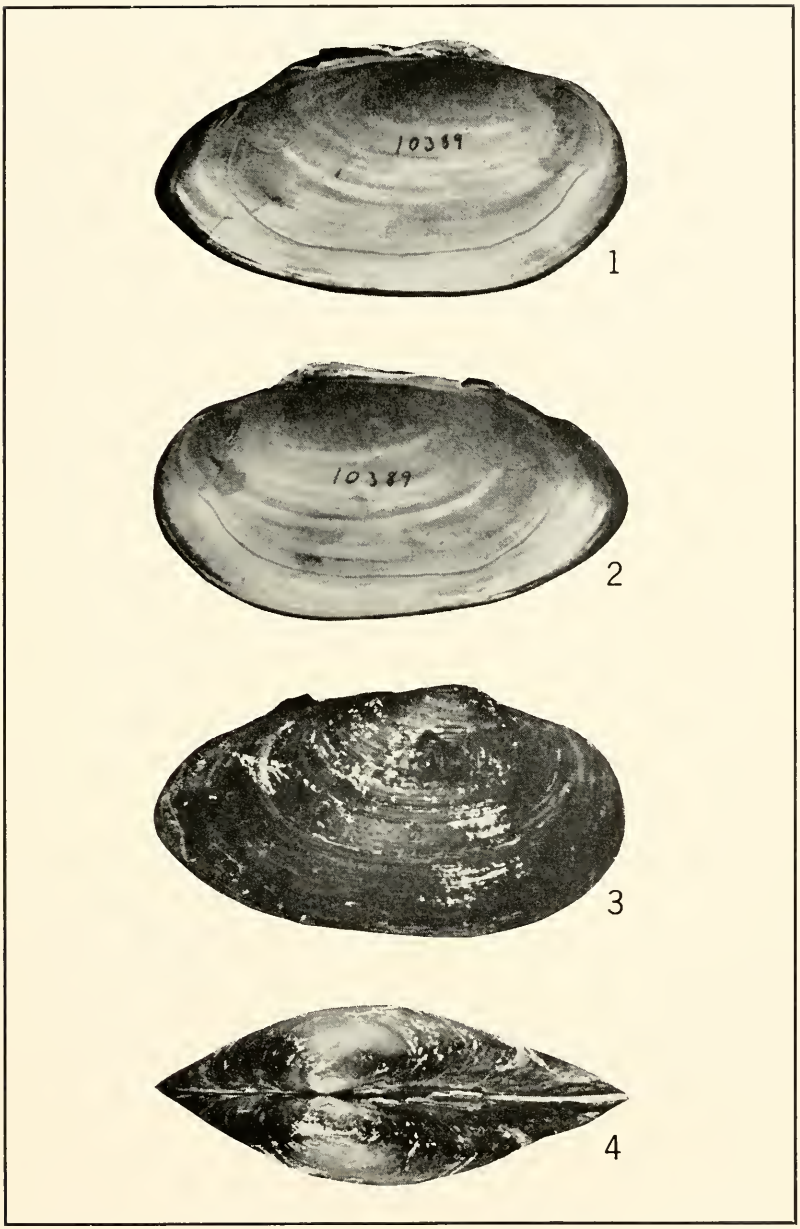
When *P. alata* is in normal feeding position the posterior wing of the shell projects upward from the substrate in which the animal is embedded. The name "heel-splitter" is probably derived from the experiences of barefoot persons who have lacerated their feet on these sharp objects.

Young specimens have a beautiful white nacre and an interesting ovate shape; however, older examples have blemishes on the nacre, and usually lose the posterior wing. Large shells were valued for buttons; however, younger shells were too brittle and split when cut. Large specimens from Kansas range from 6½ to 7 inches in length.

Genus Anodonta Lamarck 1799

Shell elliptical, thin, inflated, often slightly winged posteriorly; beak-sculpture of numerous, somewhat doubly looped, slightly nodulous, more or less parallel ridges; surface generally smooth, shining; hinge edentulous, reduced to mere line, regularly curved; nacre dull (after Walker, 1918, p. 56). Type: *Mytilus cygneus* Lamarck.

PLATE 22



Anodonta grandis Say, no. 10389; from Marais des Cygnes River, at a place 2 mi. E and 1¼ mi. N Melvern, Osage Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4⅞ inches.

Floater Mussel

Anodonta grandis Say

Plate 22, figures 1-4; text figure 18

Anodonta grandis Say, 1829, New Harmony Disseminator, 2(23):341; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:51; Call, 1885, *op. cit.*, p. 97; Call, 1885, *op. cit.*, p. 123; Call, 1886, *op. cit.*, p. 183; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19; Scammon, 1906, Univ. Kansas Sci. Bull., 3:326; Clark and Gillette, 1911, Proc. Biol. Soc. Washington, 24:68; Simpson, 1914, A descriptive catalogue . . . mussels, p. 418; Leonard, 1943, Trans. Kansas Acad. Sci., 46:231; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:391; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Anodonta danielsii, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:51; Call, 1885, *op. cit.*, p. 97; Call, 1885, *op. cit.*, p. 122; Call, 1886, *op. cit.*, p. 183; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 1:18; Scammon, 1906, Univ. Kansas Sci. Bull., 3:327.

Type Locality: Fox River of the Wabash River, Indiana.

General Distribution: Entire Mississippi River system; southwest Texas; upper St. Lawrence drainage; Red River of the North; Lake Winnipeg; Manitoba, Canada (Simpson, 1914, p. 419; Ortmann, 1912, p. 292).

Occurrence in Kansas: Anodonta grandis is common in all parts of Kansas except the extreme western and northern areas. Its occurrence in the Big Blue and Republican rivers is doubtful because these rivers have shifting sand bottoms and lack quiet pools. It is

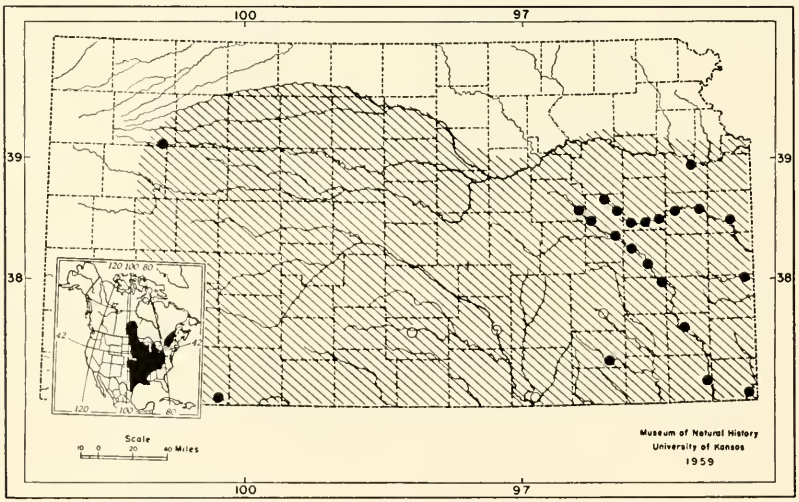


FIG. 18. Distribution of *Anodonta grandis* in Kansas. Insert map shows approximate distribution of this species in North America.

common in eastern Kansas, but only isolated populations occur in central and western Kansas.

The westernmost records for *A. grandis* in Kansas are: 1 mi. N and ¼ mi. W Oakley, Logan County (sec. 35, T. 10 S, R. 32 W); Crooked Creek, Meade County.

Description of Shell: Shell elongate, ovate, subrhomboid or subelliptical, inequilateral; beaks full, elevated above dorsal line; beak sculpture of a few strong, irregular, broken, sharply doubly looped ridges; posterior ridge full, ending behind as biangulate point at median line; postdorsal wing low, obliterated in older specimens; base line curved; epidermis greenish-brown or brownish-green, rarely faintly rayed; female ventroposterior area frequently swollen in older specimens.

Hinge edentulous, having slight thickening under beaks; beak cavities shallow; dorsal scars and adductor scars more or less distinct; nacre white, salmon, cream or pinkish; reddish or salmon stains due to parasites (after Baker, 1928, p. 152).

Ecology: A. grandis is found in lakes, ponds and streams. Large populations occur in sandy, mud bottoms in quiet pools having deep water. It is rare in areas of rock or shifting sand.

Host for Glochidia: Not recorded.

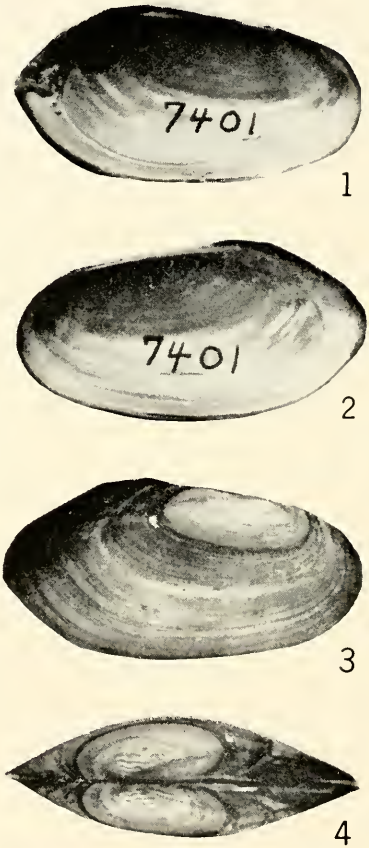
Remarks: Of the genus *Anodonta* only *A. grandis, A. suborbiculata,* and *A. imbecilis* appear to be validly recorded for Kansas. The numerous species of *Anodonta* reported from Kansas by Call (1885-1887) and Scammon (1906) are variations of *A. grandis.* Recent studies on Kansas rivers indicate that *A. suborbiculata* (p. 158) is now absent from the state.

The genus *Anodonta* is the only genus completely lacking pseudocardinal and lateral teeth on the hinge line. The differences between *A. grandis* and *A. imbecilis* are discussed under the latter.

Because of the thin shell and unreliable quality of nacre, this species was never valued for buttons. The drying qualities of the shell are poor, for shells frequently split into many fragments.

Large specimens from Kansas range from 6 to 7 inches in length.

PLATE 23



Anodonta imbecilis Say, no. 7401; from Fall River, at a place 1 mi. N and and ½ mi. W Fall River, Greenwood Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 1¾ inches.

Floater Mussel

Anodonta imbecilis Say

Plate 23, figures 1-4; text figure 19

Anodonta imbecilis Say, 1829, New Harmony Disseminator, 2(23):355; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:116; Call, 1886, *op. cit.*, p. 183; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19; Scammon, 1906, Univ. Kansas Sci. Bull., 3:324; Simpson, 1914, A descriptive catalogue . . . mussels, p. 395.

Type Locality: Wabash River.

General Distribution: "Entire Mississippi drainage, south Michigan, North Carolina; southwest to Matamoros [Tamaulipas?], Mexico" (Simpson, 1914, p. 396).

Occurrence in Kansas: *Anodonta imbecilis* is presently restricted to south-central Kansas and the tributaries of the lower Marais des Cygnes River drainage. It apparently had a much wider range in Kansas in 1906 (Scammon, p. 324).

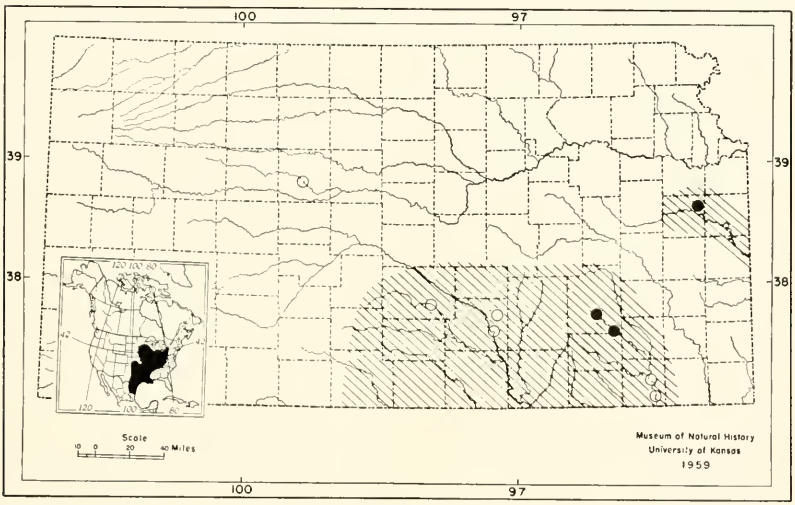


FIG. 19. Distribution of *Anodonta imbecilis* in Kansas. Insert map shows approximate distribution of this species in North America.

The westernmost record for *A. imbecilis* in Kansas is the Ninnescah River, Reno County (specimen not seen).

Description of Shell: Shell oblong, thin, inequilateral, convex or inflated; dorsal and ventral lines nearly parallel; pointed behind at or above median line; beaks compressed or flattened, not projecting above dorsal line; beak sculpture of feeble, irregular, broken ridges

forming doubly looped lines; posterior ridge low, curved down in middle; epidermis generally smooth, yellowish-green or blue-green, often banded, feebly rayed, having two or more ill-defined, dark rays on posterior slope; muscle scars scarcely visible; nacre pale blue or bluish-white (after Simpson, 1914, p. 395).

Ecology: *A. imbecilis* is found in quiet pools or small streams having muddy or sandy bottoms. It is not found in rocky habitats or in areas of shifting sand.

Host for Glochidia: Not recorded.

Remarks: In Kansas *A. imbecilis* can be confused only with *A. grandis*. It may be distinguished from the latter by the lack of a prominent umbo. The very thin, fragile shell submits this animal to easy predation. Although it is a beautiful shell, the drying qualities are poor. It was never valued for buttons. Large specimens from Kansas range from 3 to 3½ inches in length.

The specific name *imbecilis* appears in the literature as *imbecillis* and *imbecilis*. Since Say originally described the species and spelled the name *imbecilis,* this spelling is correct usage.

Genus ARCIDENS Simpson 1900

Shell subsolid, inflated, subrhomboidal; beaks full and high; beak-sculpture consisting of strong, irregular corrugations; corrugations form two loops, base of loop swollen into knobs continuing out in two radiating rows on disc of shell; many fine, radial wrinkles in front of and behind beaks, posterior ones zigzagged; surface of shell having oblique folds and wrinkles; epidermis dark olive, shining; left valve having two elongated, compressed pseudocardinals, posterior one under beak curving upwards and cutting off hinge plate of right valve; right valve having single, compressed pseudocardinal in front; laterals short, imperfect; nacre white (after Walker, 1918, p. 57). Type: *Alasmodonta confragosa* Say.

Rock Pocketbook Mussel

Arcidens confragosus (Say)

Plate 24, figures 1-3; text figure 20

Alasmodonta confragosa Say, 1829, New Harmony Disseminator, 2:339.
Arcidens confragosus, Simpson, 1900, Proc. U. S. Mus., 22:661; Simpson, 1914, A descriptive catalogue . . . mussels, p. 475.

Type Locality: New Orleans, Louisiana.

General Distribution: The Mississippi River drainage from southern Ohio west to eastern Kansas and Texas, north to southern Wisconsin and Minnesota, south to Louisiana.

Occurrence in Kansas: R. W. Reese obtained a single gravid specimen from the Marais des Cygnes River 3 miles east of Ottawa,

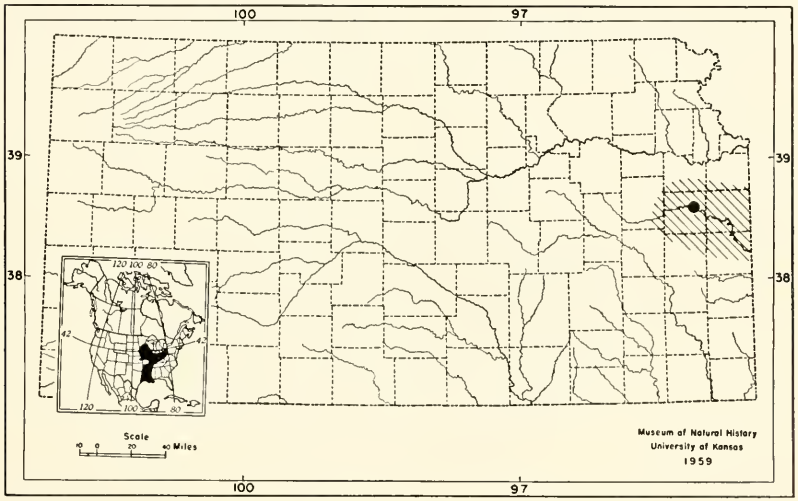


FIG. 20. Distribution of *Arcidens confragosus* in Kansas. Insert map shows approximate distribution of this species in North America.

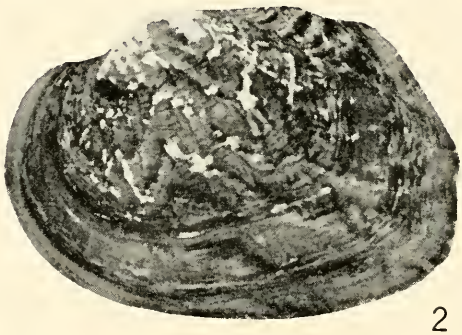
Franklin County, Kansas on September 25, 1949. Only a half shell of this specimen remains in our collection and is illustrated on plate 24. An empty shell was found at a later date at the same locality, but has subseqnently been lost. This area was carefully investigated in 1958, but no *Arcidens confragosus* were recovered.

Description of Shell: Because this is a monotypic genus, the generic description applies.

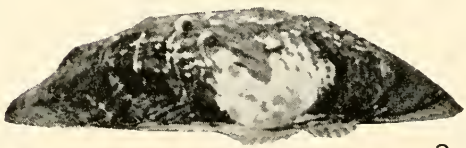
Ecology: Baker (1928, p. 197) gives the habitat of *A. confragosus* as rapid current on mud or sand bottom. Utterback (1916a, p.

PLATE 24

1



2



3

Arcidens confragosus (Say), no. 11083; from Marais des Cygnes River, 3 mi. E Ottawa, Franklin Co., Kansas. Fig. 1, interior, left valve; fig. 2, exterior, left valve; fig. 3, dorsal aspect of left valve. Actual length, 2⅝ inches.

104) reports that in Missouri it is found in quiet water on mud bottoms. In Kansas the specimens were recovered from a gravel shoal at a depth of about one foot.

Host for Glochidia: Not recorded.

Remarks: Because Utterback (1916a, p. 103) lists *A. confragosus* as occurring in the Osage (Marais des Cygnes) River in Missouri, its presence in Kansas is not surprising. It it easily recognized by the unusual sculpturing on the beaks and the shell.

A. confragosus was not valued for buttons. The largest of the two specimens from Kansas measures approximately 60 mm. (2⅜ inches) in length.

Genus Strophitus Rafinesque 1820

Shell elliptical to rhomboid, inflated, subsolid; pointed or bi-angulate behind having in some individuals double low posterior ridge; beaks full; beak sculpture of a few, strong, concentric ridges curving sharply upwards behind; epidermis rayed or rayless, shining; hinge line incurved in front of beaks; teeth rudimentary, vestigial; compressed tooth in each valve, secondary tooth in occasional shells; laterals rarely present (after Walker, 1918, p. 56). Type: *Anodonta undulata* Say.

Squaw-Foot Mussel

Strophitus rugosus (Swainson)

Plate 25, figures 1-4; text figure 21

Anodon rugosus Swainson, 1822, Zool. Ill., 1st ser., II, (no pagination), pl. 96.

Strophitus rugosus, Dall, 1905, Harriman Alaska Exped., 13:127; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:389.

Strophitus edentulus, Scammon, 1906, Univ. Kansas Sci. Bull., 3:322; Simpson, 1914, A descriptive catalogue . . . mussels, p. 345.

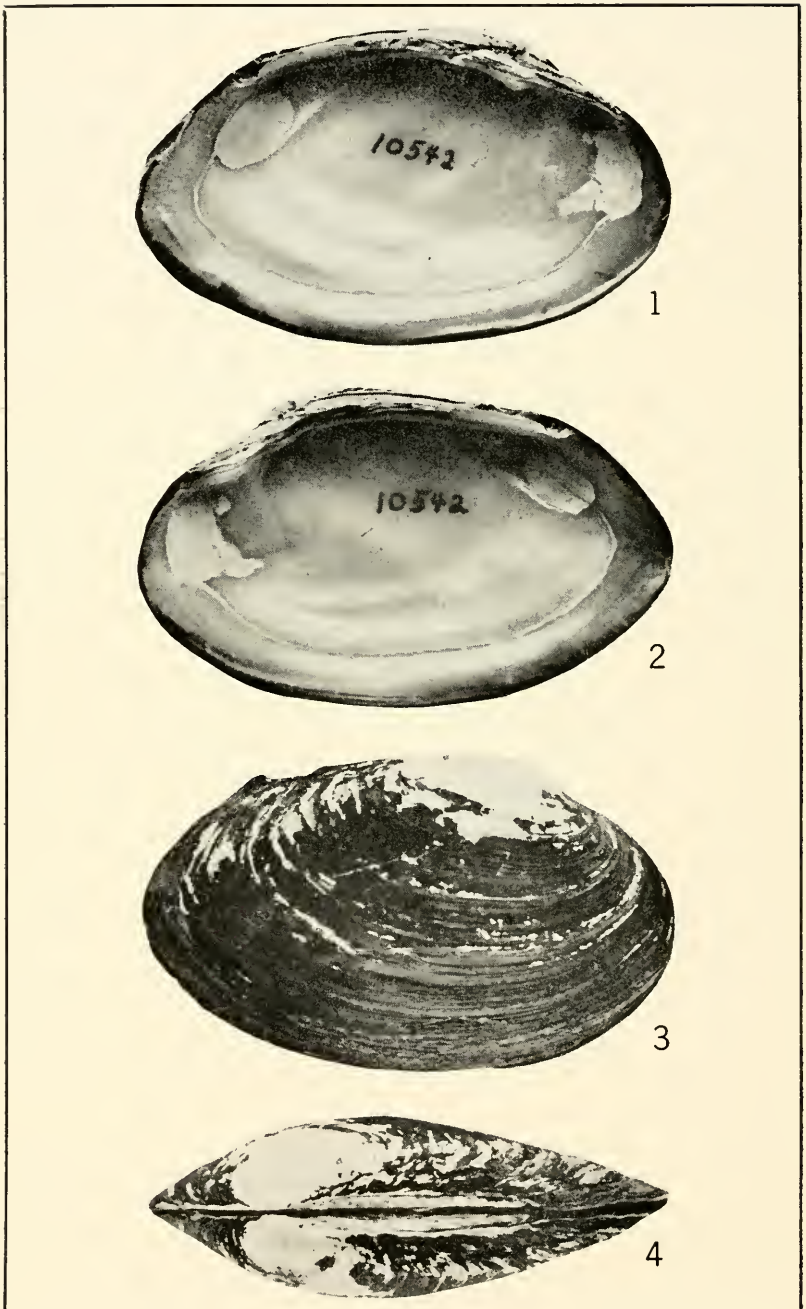
Anodonta arkansensis, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:51; Call, 1885, *op. cit.,* p. 97; Call, 1885, *op. cit.,* p. 122; Call, 1886, *op. cit.,* p. 183; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:18.

Anodonta edentula, Call, 1886, Bull. Washburn College Lab. Nat. Hist., 1:183; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:18.

Type Locality: United States.

General Distribution: Entire Mississippi drainage; St. Lawrence drainage; Atlantic drainage to North Carolina; Lake Winnipeg, Canada; central Texas to Gulf of Mexico; Alabama (La Rocque, 1953, p. 99).

PLATE 25



Strophitus rugosus (Swainson), no. 10542; from Marais des Cygnes River, 4½ mi. W and 2 mi. N Osawatomie, Miami Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsum of shell. Actual length, 3⅜ inches.

Occurrence in Kansas: Strophitus rugosus occurs in the southern portions of the Arkansas, Neosho, and Verdigris rivers, and the eastern half of the Marais des Cygnes and the Kansas river drainages. There are no records of it north of the Kansas River in Kansas.

The westernmost records for S. *rugosus* in Kansas are: Smoky Hill River, Salina, Saline County (specimen not seen); Neosho River, 2½ mi. W Americus, Lyon County (sec. 9, T. 18 S, R. 10 E); Elk River, 1 mi. S Howard, Elk County (sec. 12, T. 30 S, R. 10 E); Ninnescah River, Reno County (specimen not seen).

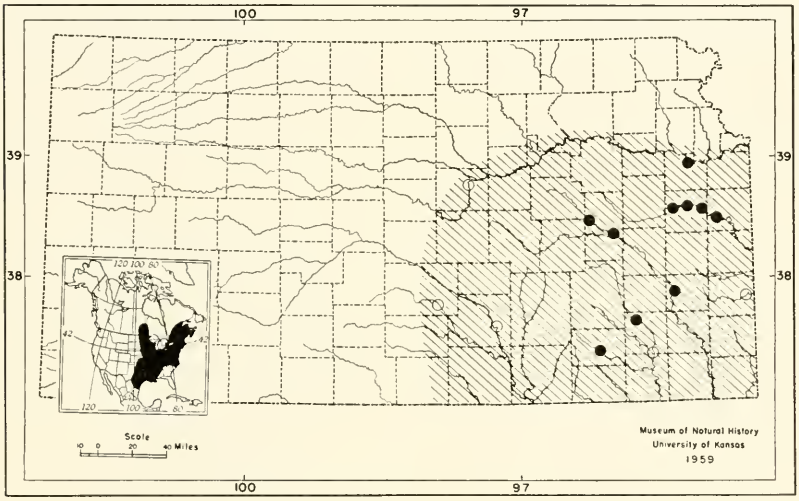


FIG. 21. Distribution of *Strophitus rugosus* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell subelliptical or subovate, thick, rather solid, moderately inequipartite; adult more or less inflated; anterior end rounded; posterior end rounded or obliquely truncated, distinctly biangulate; ventral margin slightly convex, straight, or occasionally concave in middle; dorsal margin slightly convex, forming angle with oblique posterior margin; beaks depressed, not much elevated above hinge line; beak sculpture heavy, consisting of four concentric bars, somewhat oblique to hinge line, rounded anteriorly and forming angle posteriorly; additional radiating ridges on posterior slope; posterior ridge broadly rounded, indistinct in some individuals, distinct, or acute in others; posterior slope compressed or much inflated; epidermis yellowish or greenish, brownish

and black in older specimens, more or less marked by greenish or black in older specimens, more or less marked by greenish or black rays of variable size.

Hinge plate thickened but laterals absent; pseudocardinals indicated by several small swellings or tubercules below and in front of beaks; beak cavity moderately deep containing dorsal muscle scars; adductor scars distinct; nacre white, cream-colored or salmon in center, occasionally pinkish, bluish-white, iridescent on border of valve (after Baker, 1928, p. 199).

Ecology: Baker (1928, p. 201) reports S. *rugosus* inhabiting large and medium sized rivers in mud or sand (rarely gravel) bottoms in fairly deep water. Kansas specimens are most frequently found in these habitats but occasionally are recovered from gravel and cobble bottoms.

Host for Glochidia: S. *rugosus*, *Anodonta imbecilis*, and *Obliquaria reflexa* are unusual among unionids. The glochidia may be parasitic or they may develop directly without parasitism. In the latter case the placentae, or gelatinous cords, are discharged directly into the water. Experimentally the glochidia have metamorphosed on fins and skin of the largemouth bass, *Micropterus salmoides*, and the creek chub, *Semotilus atromaculatus*.

Remarks: In Kansas, S. *rugosus* may be confused with *Anodonta grandis* but can be distinguished from the latter by the heavier shell, the presence of small nodulous pseudocardinal teeth, and the thicker hinge line.

Because of the thin shell, S. *rugosus* was not valued for buttons. The drying qualities of the shell are fair. Large specimens from Kansas vary from 4 to 4¼ inches in length.

SUBFAMILY Lampsilinae

Genus Obliquaria Rafinesque 1820

Shell inflated, solid, oval, having row of large, compressed, longitudinal knobs extending from beaks to center of base, knobs of one valve alternating in position with knobs of other valve; well developed posterior ridge, space between ridge and knobs excavated; posterior slope, in some individuals entire shell, more or less corrugately sculptured; beaks prominent, incurved, pointed slightly forward toward well-developed lunule; beak sculpture strong, four or five, parallel ridges, falling low in front, but curved upwards behind; epidermis smooth, shining, having numerous delicate, wavy, darker

broken rays; pseudocardinals strong, distinct, ragged; laterals short, nearly straight; front part of shell solid, thinner behind knobs (after Walker, 1918, p. 67). Type: *Obliquaria reflexa* Rafinesque.

Three Horned Wart-Backed Mussel

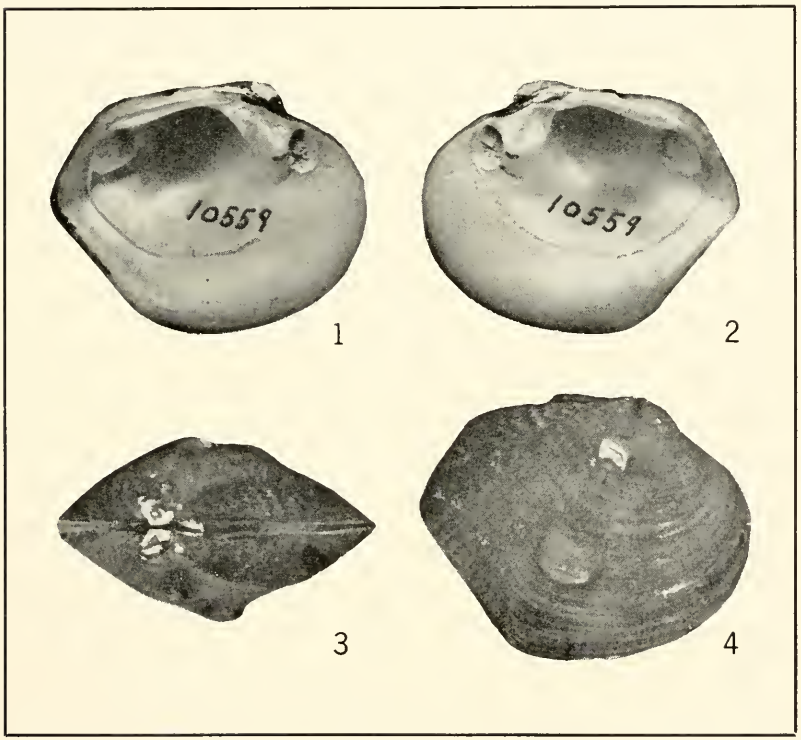
Obliquaria reflexa Rafinesque

Plate 26, figures 1-4; text figure 22

Obliquaria (*Quadrula*) *reflexa* Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:306; Scammon, 1906, Univ. Kansas Sci. Bull., 3:317; Simpson, 1914, A descriptive catalogue . . . mussels, p. 330; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118.

Unio cornutus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:93; Call, 1885, *op. cit.*, p. 119; Call, 1886, *op. cit.*, p. 180; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:20.

PLATE 26



Obliquaria reflexa Rafinesque, no. 10559; from Neosho River, at a place 2½ mi. S and 1¾ mi. W Iola, Allen Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, dorsal aspect of shell; fig. 4, exterior, right valve. Actual length, 2 inches.

Type Locality: Kentucky River, and Letart Falls, Meigs County, Ohio.

General Distribution: Throughout Mississippi River drainage from western Pennsylvania west to eastern Kansas, Oklahoma, and Texas; Georgia; Ontario, Canada.

Occurrence in Kansas: Obliquaria reflexa is restricted to the drainages of southeastern Kansas. It occurs in the lower portions of the Marais des Cygnes and Neosho rivers, but is not common.

The westernmost records for *O. reflexa* in Kansas are: Marais des Cygnes River, Ottawa, Franklin County; Neosho River, ½ mi. N and 3 mi. W Neosho Rapids, Lyon County (sec. 24, T. 17 S, R. 12 E); Walnut River, Arkansas City, Cowley County (specimen not seen).

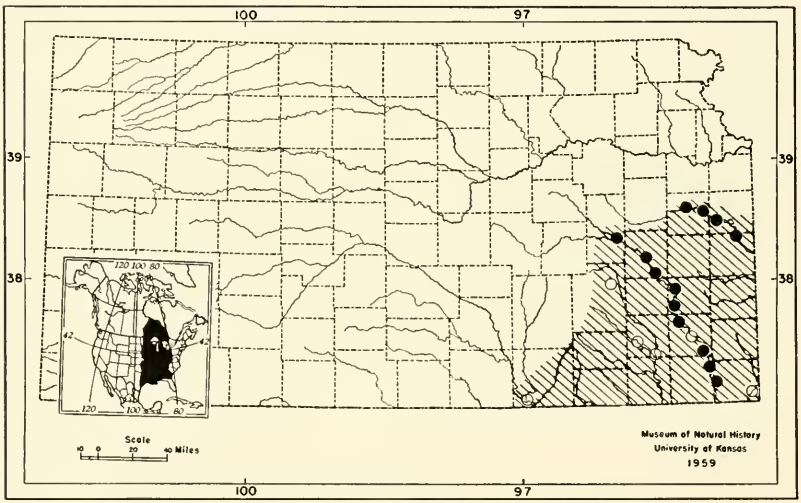


FIG. 22. Distribution of *Obliquaria reflexa* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Because this is a monotypic genus, the generic description applies to this species.

Ecology: In Kansas *O. reflexa* inhabits large streams in sand, gravel, or hard mud bottoms in areas of more or less rapid current. It does not occur in soft mud bottoms.

Host for Glochidia: Howard (1914, p. 44) indicates that this species may complete its life cycle without being parasitic on fishes, in the same manner as *Strophitus rugosus* and *Anodonta imbecilis.*

Remarks: O. reflexa resembles *Quadrula nodulata* and is distinguished from the latter, and all other unionids in the Mississippi Valley, by the presence of 2-4 knobs distributed from the beaks to the center base in such a manner that knobs of one valve alternate in position with those on the opposing valve; in *Q. nodulata* the knobs of one valve are situated opposite the knobs of the opposing valve.

Because of the small size, large knobs, and thin posterior end, the unusual shell of *O. reflexa* was not valued for buttons. The drying qualities of the shell are excellent. Large specimens from Kansas range from 2¾ to 3 inches in length.

Genus Cyprogenia Agassiz 1852

Shell solid, inflated, rounded, triangular, sometimes slightly retuse, generally somewhat biangular behind; posterior ridge usually well developed; umbonal region flattened, parallel to axis of shell, sometimes compressed; beaks curved inward and forward; beak sculpture of faint, slightly double looped ridges; sculpture of shell nodular, radiately wrinkled, or lachrymose; ligament black, conspicuous; lunule distinct, well developed; epidermis shining, having delicate mottling on light ground; hinge plate wide, flat; pseudocardinals heavy, triangular, blunt, ragged; laterals short, obliquely striated; beak cavity shallow; nacre bright, silvery (after Walker, 1918, p. 68). Type: *Unio irroratus* Lea.

Young Fan-Tailed Mussel

Cyprogenia aberti (Conrad)

Plate 27; figures 1-4; text figure 23

Unio aberti Conrad, 1850, Proc. Acad. Nat. Sci., Philadelphia, 5:10; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:11.

Cyprogenia aberti, Simpson, 1900, Proc. U. S. Nat. Mus., 22:610; Scammon, 1906, Univ. Kansas Sci. Bull., 3:315; Simpson, 1914, A descriptive catalogue . . . mussels, p. 328.

Unio popenoi, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:48; Call, 1886, *op. cit.,* p. 182.

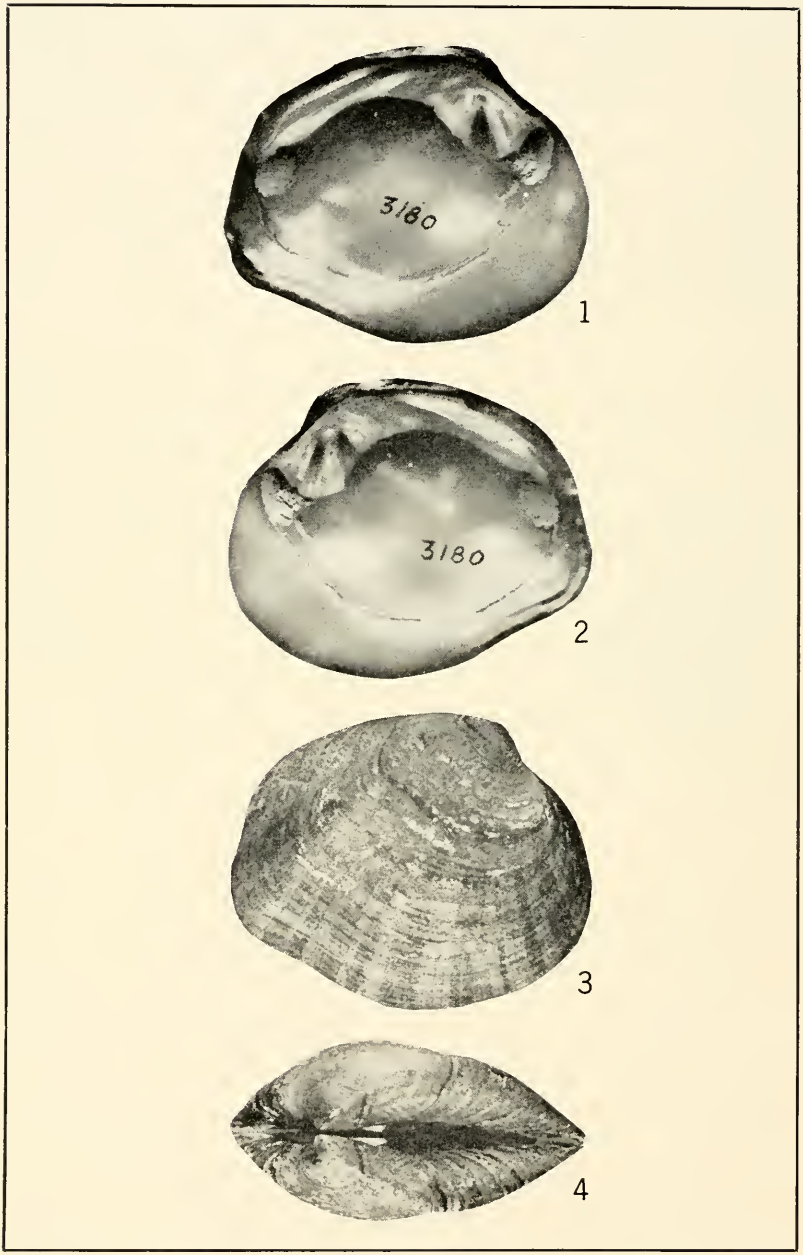
Type Locality: Verdigris River, Arkansas.

General Distribution: Limited in range to the southeastern portion of Kansas, southern Missouri, eastern Oklahoma, and Arkansas.

Occurrence in Kansas: Cyprogenia aberti is restricted to the Verdigris and Neosho river drainages in Kansas.

The westernmost record for *C. aberti* in Kansas is somewhere on the Neosho River, Lyon County.

PLATE 27



Cyprogenia aberti (Conrad), no. 3180; from Neosho River, Lyon Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 3 inches.

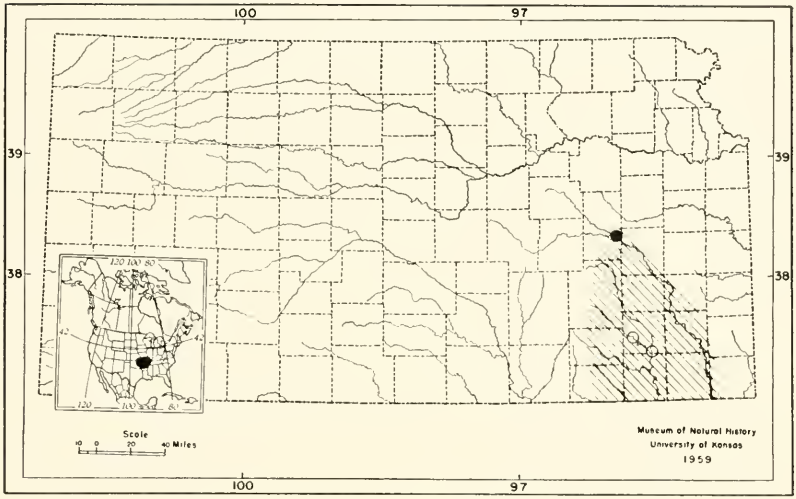


FIG. 23. Distribution of *Cyprogenia aberti* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell solid, somewhat rhomboid, slightly inflated; beaks low, compressed, turned forward over lunule, having faint sculpture; posterior ridge rather sharp dorsally, gradually becoming less distinct and slightly double in later growth; disc flattened above; posterior slope having wide, shallow, radial furrow behind posterior ridge; surface of shell having low, wide, concentric ridges; epidermis somewhat shiny or yellowish-green, having dots and flecks of dark green arranged in broken rays.

Left valve having two low, radial pseudocardinal teeth, right valve having one pseudocardinal, sometimes an accessory denticle to each side; beak cavity shallow, compressed; interdentum wide, flat; muscle scars small, smooth, impressed; nacre white (after Simpson, 1914, p. 328).

Ecology: There are no data on the ecology of this species in Kansas or Missouri. The bottom conditions of Kansas rivers from which *C. aberti* has been reported are rock, gravel, and soft mud.

Host for Glochidia: Not recorded.

Remarks: Because of the compressed shell, oval shape, and light green markings on the shell, *C. aberti* will not be confused with any other Kansas unionid.

If *C. aberti* presently occurs in the southern drainages, it is rare. No specimens have been recovered since 1906. The largest *C. aberti* reported for Kansas measures approximately 3⅝ inches long.

Genus Actinonaias Fischer and Crosse 1893

Shell ovate or subelliptical, distinctly longer than high, compressed or slightly inflated, lacking or having indistinct posterior ridge; disc not sculptured; beaks moderately anterior, never in middle, never at anterior end; beak sculpture of poorly developed, double-looped, faint bars obliterated in central parts; epidermis yellowish to greenish, generally having distinct green rays; differences between male and female shells scarcely noticeable (after Ortmann, 1912, p. 324). Type: *Unio sapotalensis* Lea.

Mucket Mussel

Actinonaias carinata carinata (Barnes)

Plate 28, figures 1-4; text figure 24

Unio carinatus Barnes, 1823, Amer. Jour. Sci., 6:259, pl. 13, fig. 10.

Actinonaias carinata, Ortmann and Walker, 1922, Occas. Papers Mus. Zool., Univ. Michigan, no. 112, p. 47.

Unio ligamentinus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 120; Call, 1886, *op. cit.*, p. 180; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21.

Lampsilis ligamentinus, Scammon, 1906, Univ. Kansas Sci. Bull., 3:289; Simpson, 1914, A descriptive catalogue . . . mussels, p. 79.

Type Locality: Fox River, Wisconsin.

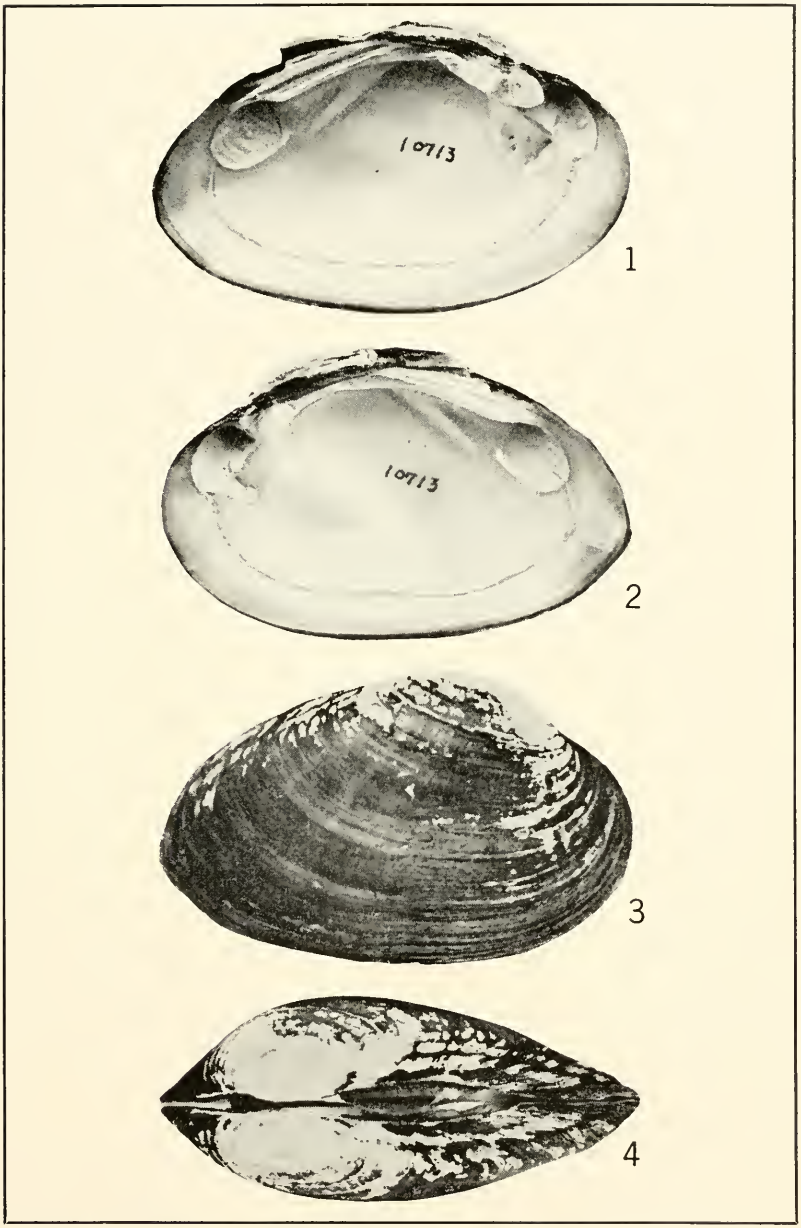
General Distribution: Mississippi River drainage as far west as Kansas; St. Lawrence River drainage; southern Ontario and Manitoba, Canada; Lake St. Clair and its drainage; Lake Erie drainage; Niagara River and its tributaries; Lake Ontario (Baker, 1928, p. 221; La Rocque, 1953, p. 85).

Occurrence in Kansas: Actinonaias carinata carinata is now restricted to southeastern Kansas. Scammon (1906, p. 291) reported it as uncommon in the Kansas and Wakarusa rivers and common in the Marais des Cygnes River. In 1919 it occurred in the Neosho River as far north as Emporia (Coker, 1919, p. 28). Recent investigations in these same areas indicate that the "mucket mussel" is presently found only in the Neosho and Spring rivers. It probably ranges no farther north than the western edge of Allen County.

The westernmost records for *A. c. carinata* in Kansas are: Neosho River, Emporia, Lyon County; Fall River, Eureka, Greenwood County (specimen not seen).

Description of Shell: Shell thick, heavy, subovate or subelliptical, inequipartite; anterior end rounded; posterior end pointed; ventral margin broadly rounded; dorsal margin almost straight; posterior ridge rounded, faint or absent; shell usually not much inflated, young

PLATE 28



Actinonaias carinata carinata (Barnes), no. 10713; from Neosho River, 1½ mi. E Oswego, Labette Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4¼ inches.

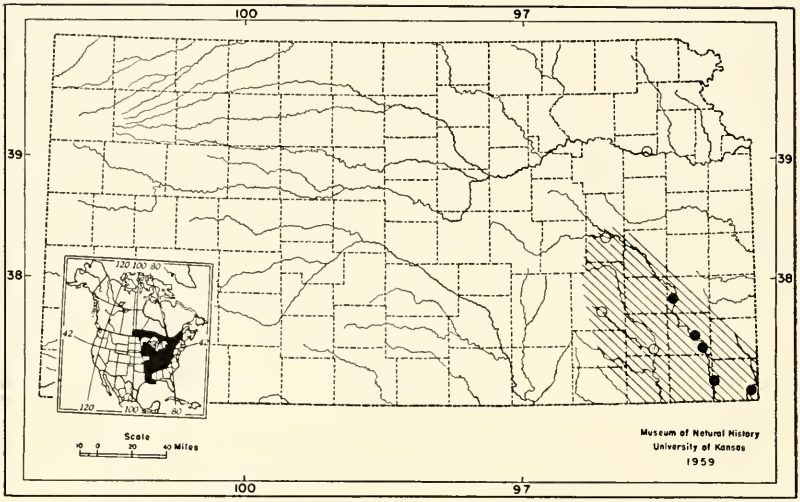


FIG. 24. Distribution of *Actinonaias carinata carinata* in Kansas. Insert map shows approximate distribution of this species in North America.

individuals quite compressed; beaks somewhat swollen, not much elevated above dorsal margin; beak sculpture consisting of a few delicate, more or less distinct bars, somewhat double-looped; surface lacking sculpture, growth lines occasionally exaggerated at rest periods and dark bordered; epidermis yellowish, greenish, olive or brownish-yellow, having many broad green rays usually increasing in width from umbones; old individuals usually rayless becoming brown or blackish; concentric bands of color rarely present; female shell having post-basal region slightly more rounded than male shell.

Two large, subtriangular, elevated, heavy, serrated, divergent pseudocardinal teeth in left valve, one in right valve, some individuals having one small anterior and posterior tooth in right valve; laterals long, elevated, strong, heavy, somewhat roughened, two in left, one in right valve; interdentum long, narrow; beak cavity moderately deep; dorsal muscle scars in beak cavity and on hinge plate; anterior adductor muscle scar deeply excavated, sulcate; posterior scar distinct; nacre silvery white, often faintly cream colored, iridescent posteriorly (after Baker, 1928, p. 218).

Ecology: Typically this species is found in large rivers on riffles having sand and gravel bottoms. Occasionally it is found on hard, rocky bottoms wedged between large rocks (Baker, 1928, p. 220). In Kansas, specimens occur in sandy, muddy, rocky, and gravelly stream bottoms.

Host for Glochidia: The glochidia have been found naturally on the gills of: *Lepomis cyanellus*, green sunfish; *L. macrochirus*, bluegill; *Micropterus dolomieui*, small-mouthed bass (Baker, 1928, p. 220). Infection by artificial means has occurred on several other game fishes.

Remarks: The southern variety of this species, *A. c. gibba* Simpson, would be expected to occur in Kansas. *A. c. gibba* is described as "Shell considerably shorter and more solid than the type, with a decided, curved, posterior ridge, the dorsal region much rounded or humped; surface having strong, low concentric ridges, muscle scars smaller than in the typical shell" (Simpson, 1914, p. 82). Because specimens from Kansas are elongate and not humped or rounded, are unlike the *gibba* reported from Missouri, and agree with the description applied to the northern forms, we judge that specimens from Kansas are of the subspecies *carinata* as previously reported by Scammon (1906, p. 290).

The even thickness of the shell, the smooth epidermis, and the beautiful nacre, made this one of the most highly valued shells for buttons. Older specimens show a definite bluing of the posterior area of the nacre, a darkening of the epidermis, and an absence of periostracum from the umbonal region. Large specimens from Kansas range from 5 to 5½ inches in length.

Genus Truncilla Rafinesque 1819

Shell rounded, oval or subtriangular, solid, inflated, generally smooth, rayed; beak sculpture delicate often obsolete, double-looped; shell of female differing from that of male, having post-basal region inflated, thinner than remainder of shell and of different texture; epidermis having broken, somewhat triangular rays; lacking a wide, radiate posterior furrow; pseudocardinals rather compressed, high, ragged; hinge plate narrow (after Walker, 1918, p. 80). Type: *Truncilla truncata* Rafinesque.

Deer Toe Mussel

Truncilla truncata Rafinesque

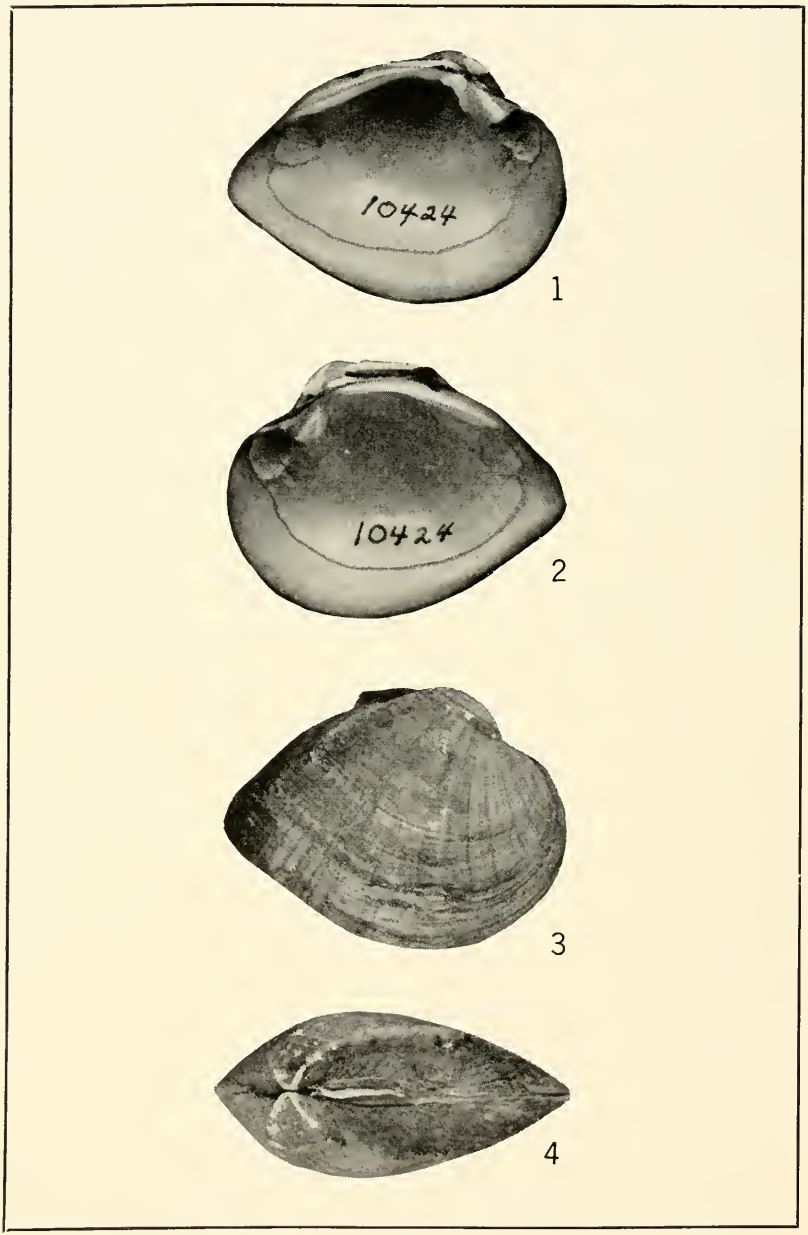
Plate 29, figures 1-4; text figure 25

Truncilla truncata Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:301.

Plagiola elegans, Scammon, 1906, Univ. Kansas Sci. Bull., 3:309; Simpson, A descriptive catalogue . . . mussels, p. 307.

Unio elegans, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 120; Call, 1886, *op. cit.*, p. 180; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21.

PLATE 29



Truncilla truncata Rafinesque, no. 10424; from Marais des Cygnes River, at a place 4½ mi. W and 2 mi. N Osawatomie, Miami Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 2 inches.

Type Locality: Ohio River.

General Distribution: Throughout the Mississippi River drainage from western Pennsylvania west to Iowa and eastern Kansas, north to Minnesota and Michigan, south to northern Alabama, Tennessee and Texas (Baker, 1928, p. 226).

Occurrence in Kansas: Truncilla truncata occurs in the eastern one-fourth of the state. It is common in the Marais des Cygnes River, but is rare in the Neosho River. Its occurrence north of the Kansas River is doubtful.

The westernmost records for *T. truncata* in Kansas are: Wildcat Creek, Riley County (specimen not seen); Neosho River, 2½ mi. W Americus, Lyon County (sec. 9, T. 18 S, R. 10 E); Little Arkansas River, Wichita, Sedgwick County (specimen not seen).

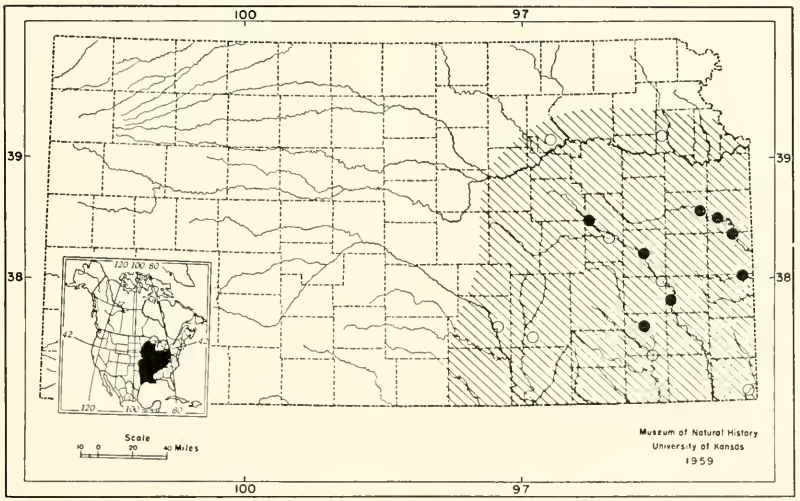


FIG. 25. Distribution of *Truncilla truncata* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell subtrigonal, thick, solid, somewhat compressed; anterior end rounded, posterior end obliquely truncated, joining the short, slightly rounded dorsal margin at a sharp angle; ventral margin convex, curved upwards into posterior margin, producing sharp posterior end; posterior ridge sharp having excavated area behind and slight radial furrow in front; beaks elevated slightly, incurved; beak sculpture of 3-4 fine bars; epidermis greenish, yellowish or yellowish-brown, usually distinctly rayed or having dark green spots, in some forming zigzag pattern; in older specimens

rays disappearing and shell brownish to black; secondary sexual differences slight.

Pseudocardinals triangular, compressed, elevated, subparallel, strongly serrated, two in left valve, one in right valve; some shells having small denticle in front and above tooth of right valve, very old shells frequently having second denticle posteriorly; interdentum narrow; beak cavities shallow; anterior muscle scars deeply impressed; posterior muscle scars distinct; nacre silvery-white, occasionally pinkish, iridescent posteriorly (after Baker, 1928, p. 224).

Ecology: In Kansas *T. truncata* is found in hard and soft mud, sand mixed with mud, rocky, and gravel bottoms of large and small streams.

Host for Glochidia: Not recorded.

Remarks: T. truncata may be confused with *T. donaciformis*. The differences between these are discussed under *T. donaciformis*.

Because of the small size, *T. truncata* was not valued for buttons. The nacre is beautiful, and as in *T. donaciformis* it is rarely blemished. The drying qualities of the shell are excellent. Large specimens from Kansas range from 2¾ to 3 inches in length.

Fawn's Foot Mussel

Truncilla donaciformis (Lea)

Plate 30, figures 1-4; text figure 26

Unio donaciformis Lea, 1828, Trans. Amer. Phil. Soc., 3:267, pl. 4, fig. 3; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1886, *op. cit.*, p. 180; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

Truncilla donaciformis, Ortmann and Walker, 1922, Occas. Papers Mus. Zool. Univ. Michigan, no. 112, p. 50; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:378.

Plagiola donaciformis, Scammon, 1906, Univ. Kansas Sci. Bull., 3:310; Simpson, 1914, A descriptive catalogue . . . mussels, p. 308.

Unio zigzag, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:51; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:23.

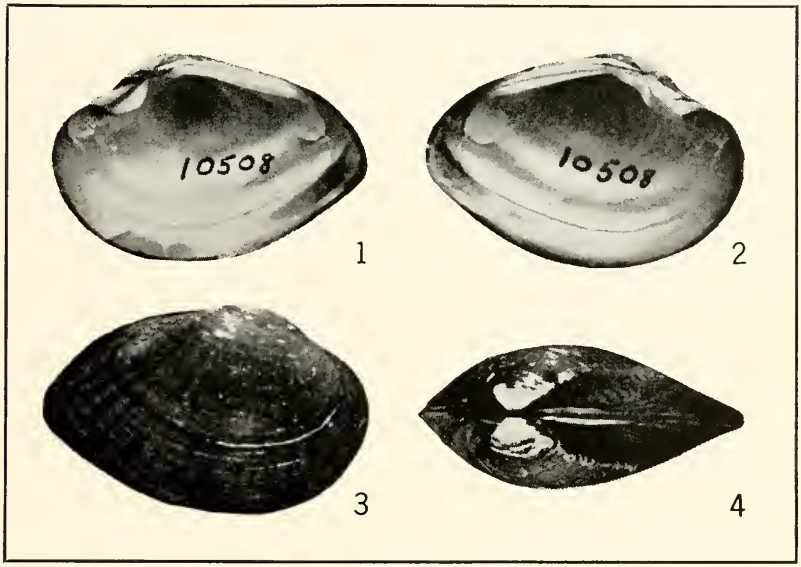
Type Locality: Ohio.

General Distribution: Throughout the Mississippi River drainage from western Pennsylvania west to eastern Kansas and eastern Texas, from Louisiana north to Minnesota; Alabama (Baker, 1928, p. 230).

Occurrence in Kansas: T. donaciformis occurs in the eastern portion of Kansas south of the Kansas River. It is common in the Neosho and Marais des Cygnes rivers. It has not been recorded

from the Verdigris River; however it probably occurs in the lower stretches of that stream.

PLATE 30



Truncilla donaciformis (Lea), no. 10508; from Neosho River, 1 mi. S Ottumwa, Coffey Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 1⅝ inches.

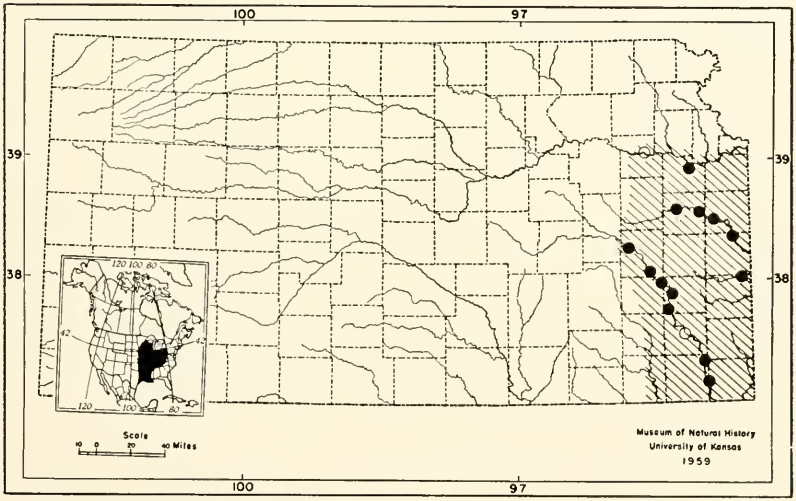


FIG. 26. Distribution of *Truncilla donaciformis* in Kansas. Insert map shows approximate distribution of this species in North America.

The westernmost records for *T. donaciformis* in Kansas are: Kansas River, Topeka, Shawnee County (specimen not seen); Neosho River, Strawn, Coffey County (sec. 33, T. 20 S, R. 14 E).

Description of Shell: Shell ovate or elongate-ovate, inequipartite, strong, not solid; anterior end rounded; ventral margin strongly convex, curving up sharply posteriorly; dorsal margin slightly convex, curving with sloping posterior end to form more or less sharply biangulate point; beaks full, slightly elevated above dorsal margin; beak sculpture of 3-4 fine bars; posterior ridge well rounded, having slight posterior depression, no anterior radial furrow; epidermis greenish or yellowish, most shells marked by many dark green rays broken to form definite zigzag or arrow-head lines; growth lines roughened on posterior slope; shell gaps widely anteriorly; male shell usually more sharply pointed posteriorly than female shell.

Hinge light; pseudocardinals compressed, slightly divergent, triangular, serrated, two in left valve, one in right valve; frequently vestigial tooth anterior to pseudocardinal of right valve; laterals elevated, straight, somewhat lamellar, slightly roughened; beak cavity shallow; muscle scars distinct; nacre silvery-white (after Baker, 1928, p. 229).

Ecology: T. donaciformis inhabits large rivers in sand or mud bottoms (Baker, 1928, p. 230). In Kansas it seems to occupy a wide variety of habitats from rocky mud, to sand and gravel bottoms. It is not restricted to the larger streams of Kansas.

Host for Glochidia: The glochidia are commonly found on freshwater drum, *Aplodinotus grunniens* and rarely found on the sauger, *Stizostedion canadense* (Surber, 1913, p. 109).

Remarks: In Kansas *T. donaciformis* is easily confused with *T. truncata.* When present, the definite zigzag marks on the shell of *T. donaciformis* distinguish it from *T. truncata. T. donaciformis* is more elongate and less trigonal, and has a rounded, angular posterior ridge. *T. donaciformis* may also be confused with *Dysnomia triquetra;* the differences between these two species are discussed in the account of *D. triquetra.*

Because of its small size, *T. donaciformis* was not valued for buttons. The drying qualities of the shell are excellent. Large specimens from Kansas range from 1¾ to 2 inches in length.

Genus Plagiola Rafinesque 1819

Shell solid, surface irregularly, concentrically ridged; epidermis smoothish having larger and smaller scattered rays in irregular lunate or squarish blotches; hinge heavy and strong; hinge plate wide

and flat; shell smaller in female than in male, more inflated and swollen at post-basal region (after Walker, 1918, p. 69). Type: *Unio securis* Lea (= *Obliquaria lineolata* Raf.).

Butterfly Mussel

Plagiola lineolata (Rafinesque)

Plate 31, figures 1-4; text figure 27

Obliquaria (Plagiola) lineolata Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:303.

Plagiola lineolata, Agassiz, 1852, Arch. für Nat., 1:48.

Plagiola securis, Scammon, 1906, Univ. Kansas Sci. Bull., 3:307; Simpson, 1914, A descriptive catalogue . . . mussels, p. 304.

Unio securis, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:94; Call, 1886, *op. cit.,* p. 178.

Type Locality: Falls of the Ohio at Louisville, Kentucky.

General Distribution: Mississippi River drainage from western Pennsylvania west to Iowa, north to Minnesota, south to Kansas and Oklahoma; Alabama (Baker, 1928, p. 233).

Occurrence in Kansas: Plagiola lineolata occurs in the southern portion of the Neosho River drainage. Scammon (1906, p. 308) reported it from the Spring and Verdigris rivers. We have not seen specimens from these rivers, but there is no reason to doubt its occurrence there. According to Utterback (1916a, p. 151) *P. lineolata* is common in the Osage River in Missouri, but there are no records of its occurrence in the same river (Marais des Cygnes) in Kansas.

The westernmost records for *P. lineolata* in Kansas are: Neosho River, 2½ mi. S and 1½ mi. W Iola, Allen County (sec. 9, T. 23 S, R. 18 E); Fall River, Wilson County (specimen not seen).

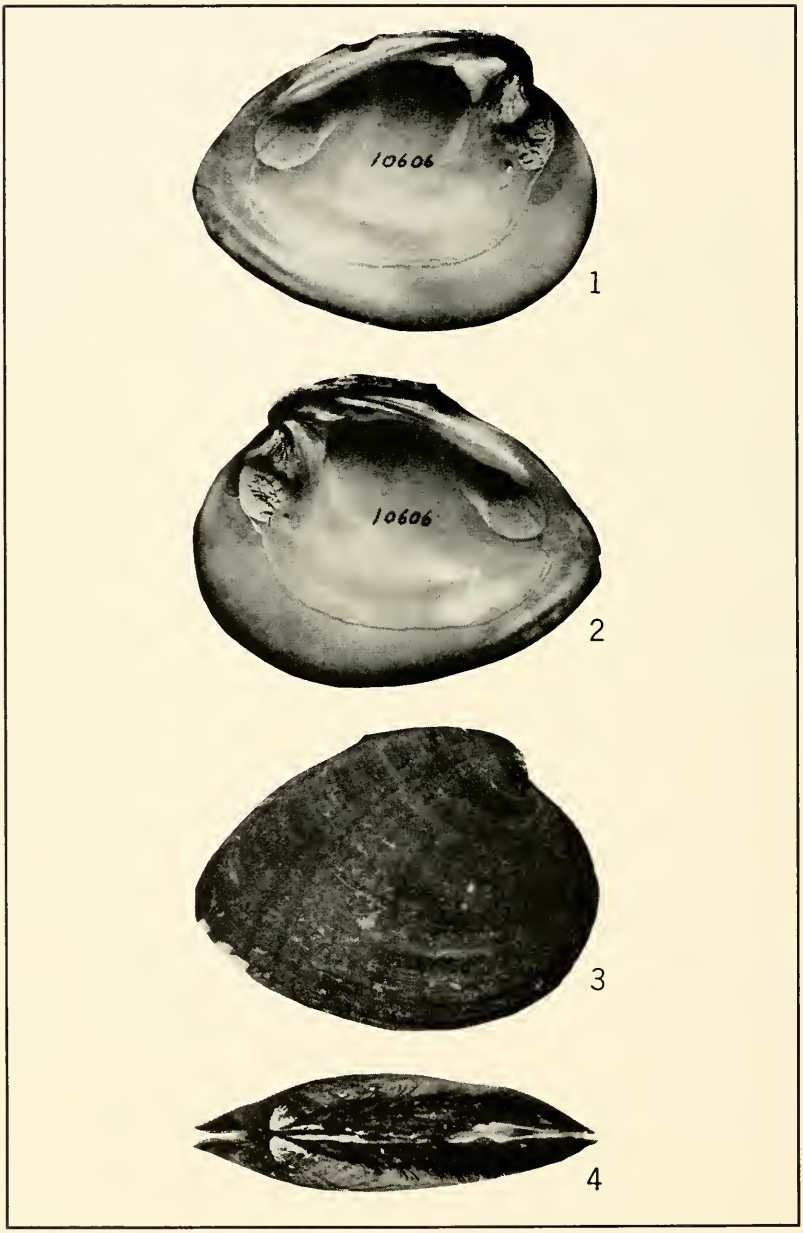
Description of Shell: Because this is a monotypic genus, the generic description applies to this species.

Ecology: The butterfly mussel is found in large rivers, where it usually inhabits areas of sand and gravel. In Kansas this species does not occur in a substrate of cobbles larger than 3 inches in diameter.

Host for Glochidia: The glochidia are found on the gills of *Aplodinotus grunniens,* the freshwater drum (Baker, 1928, p. 232).

Remarks: The dorsal ridge of the shell of the female is not so sharp as that of the male. The umbones of both sexes are greatly flattened, and the umbo cavities are correspondingly shallow; considering the thickness of the shell, this is the most conspicuously compressed unionid in Kansas.

PLATE 31



Plagiola lineolata (Rafinesque) no. 10606; from Neosho River, at a place 1½ mi. E and 1 mi. S St. Paul, Neosho Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 3⅞ inches.

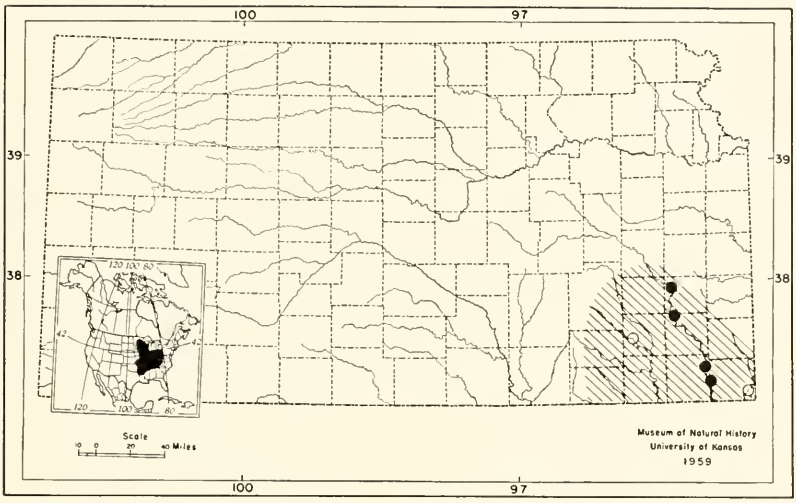


FIG. 27. Distribution of *Plagiola lineolata* in Kansas. Insert map shows approximate distribution of this species in North America.

Shells of specimens from Kansas vary from a greenish-yellow to a light brown. The posterior, dorsal, and anterior areas of some are black; shells of young individuals are paler and lack the black areas.

Although Scammon (1906, p. 308) reported this to be a common species, the authors have found it only rarely. The heavy siltation of the southern drainages in recent years may account for its decline in southeastern Kansas.

The shell was valued for buttons. The drying qualities of the shell are good, but small cracks may appear in the ventral portion of the shell. The nacre is usually a beautiful white, but yellowing of the pseudocardinal and lateral teeth does occur. Large specimens from Kansas range from 3 to 4½ inches in length.

Genus LEPTODEA Rafinesque 1820

Shell large, thin, elliptical or slightly obovate, compressed, winged on dorsal margin; beaks low; epidermis rather smooth, often feebly rayed, dull colored, sometimes glossy; pseudocardinal teeth compressed, feebly or more often imperfectly developed; nacre purplish; shells of male and female nearly alike, that of female scarcely swollen at post-basal region (after Walker, 1918, p. 72). Type *Unio gracilis* Barnes.

Fragile-Paper Mussel

Leptodea fragilis (Rafinesque)

Plate 32, figures 1-4; text figure 28

Unio (*Leptodea*) *fragilis* Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:295.

Leptodea fragilis, Ortmann and Walker, 1922, Occas. Papers Mus. Zool. Univ. Michigan, no. 112, p. 53; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:118; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:386.

Unio gracilis, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 120; Call, 1886, *op. cit.*, p. 181; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21.

Lampsilis gracilis, Scammon, 1906, Univ. Kansas Sci. Bull., 3:302.

Leptodea gracilis, Simpson, 1914, A descriptive catalogue . . . mussels, p. 181.

Type Locality: Ohio River.

General Distribution: Throughout the Mississippi River drainage from eastern New York west to Kansas and Iowa, south to Texas, Mississippi and Alabama, and north to northern Wisconsin and Minnesota; St. Lawrence River drainage; Red River of the North; and Hudson River.

Occurrence in Kansas: *Leptodea fragilis* is common in the Neosho, Verdigris and Marais des Cygnes rivers. It is not known north of the Kansas River except for the locality reported from Wild Cat Creek, Riley County, Kansas (Call, 1885, p. 95). This record could have been based on *L. laevissima* which generally replaces *L. fragilis* north of the Kansas River.

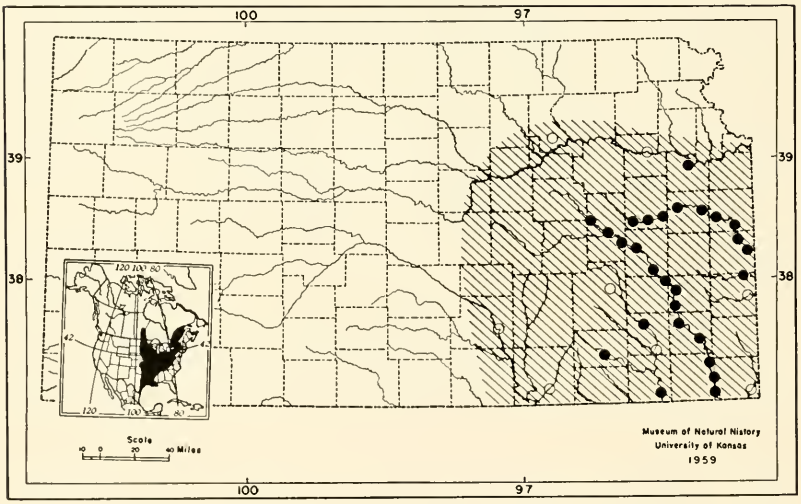
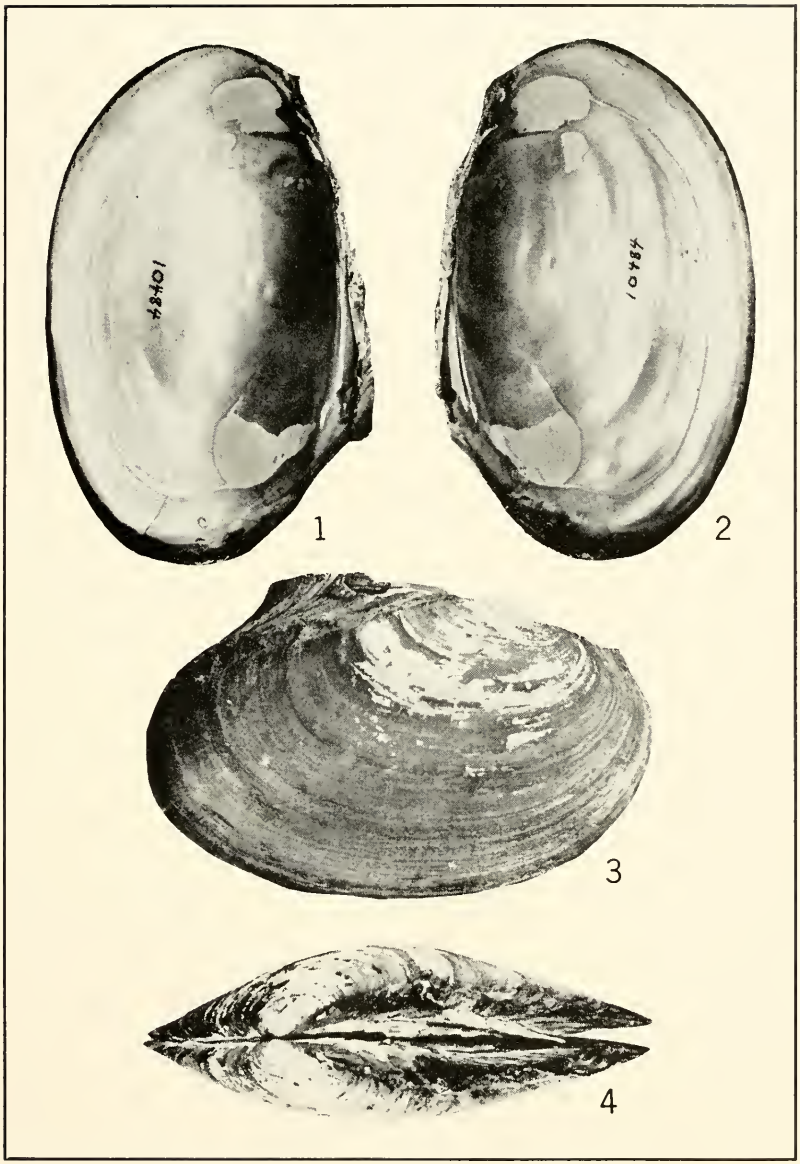


FIG. 28. Distribution of *Leptodea fragilis* in Kansas. Insert map shows approximate distribution of this species in North America.

PLATE 32



Leptodea fragilis (Rafinesque), no. 10484; from Neosho River, at a place ½ mi. N and 3 mi. W Neosho Rapids, Lyon Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 5⅝ inches.

The westernmost records for *L. fragilis* in Kansas are: 2½ mi. W Americus, Lyon County (sec. 9, T. 18 S, R. 10 E); Little Arkansas River, Wichita, Sedgwick County (specimen not seen); Elk River, 3 mi. N and 1 mi. W Elk Falls, Elk County (sec. 28, T. 30 S, R. 11 E); Silver Creek, Cowley County (specimen not seen).

Description of Shell: Shell large, thin, brittle, subovate or subelliptical; anterior end rounded; ventral margin convex, curved upward into obliquely truncated posterior margin; dorsal margin straight, having slight wing posteriorly, wing obliterated in older shells; posterior ridge weak; valve compressed posteriorly; beaks only slightly elevated above dorsal line; beak sculpture of 3-4 faint, concentric, doubly looped bars, only posterior loop distinct; epidermis smooth, marked by concentric growth lines at rest periods; epidermis dull, yellowish, pale greenish-yellow or light brown; rayed or rayless, rays if present ill-defined, straight, wide or narrow; shell of female expanded at post-basal region.

Pseudocardinals small, compressed, parallel to hinge line, more or less lamellar; two in left valve, one in right valve; laterals long, thin, compressed, lower in left valve feebly developed; no interdentum; beak cavity shallow; dorsal muscle scars form oblique row in beak cavity; anterior scars well impressed; posterior scars less so; nacre silvery-white having pinkish tint in posterior part, or all pinkish (after Baker, 1928, p. 234).

Ecology: In Kansas *L. fragilis* inhabits deep and shallow streams. It occurs also in sand, mud, and rocky bottoms but usually in quiet pondlike areas of a stream.

Host for Glochidia: Not recorded.

Remarks: In Kansas *L. fragilis* may be confused with *L. laevissima*. The latter has a thinner shell, a richer and darker purple nacre, a shining greenish-yellow epidermis, and a more prominent dorsoposterior wing. *L. fragilis* is replaced by *L. laevissima* north of the Kansas River.

The thin shell was never valued for buttons. Large cracks may appear in the shell, and the shell may break into several pieces. Because it lacks a solid hinge line and solid teeth, there are frequently blemishes and mud in the dorsal area of the shell which may obliterate the hinge line area. Huge areas of the nacre may be pushed into folds in an attempt to restrict the mud. The nacre of young animals, of an iridescent pink or light purple, is strikingly attractive. Large specimens from Kansas range from 5½ to 6 inches in length.

Paper-Shell Mussel

Leptodea laevissima (Lea)

Plate 33, figures 1-4; text figure 29

Symphynota laevissima Lea, 1830, Trans. Amer. Phil. Soc., 3:444, pl. 13, fig. 23.

Leptodea laevissima, Goodrich and van der Schalie, 1944, Amer. Midl. Nat., 32:316.

Unio laevissimus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 120; Call, 1886, *op. cit.*, p. 181; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21.

Lampsilis laevissima, Scammon, 1906, Univ. Kansas Sci. Bull., 3:303; Simpson, 1914, A descriptive catalogue . . . mussels, p. 183.

Type Locality: Ohio.

General Distribution: Throughout the Mississippi River drainage from western New York west to eastern Texas and central Kansas, from Minnesota south to Louisiana.

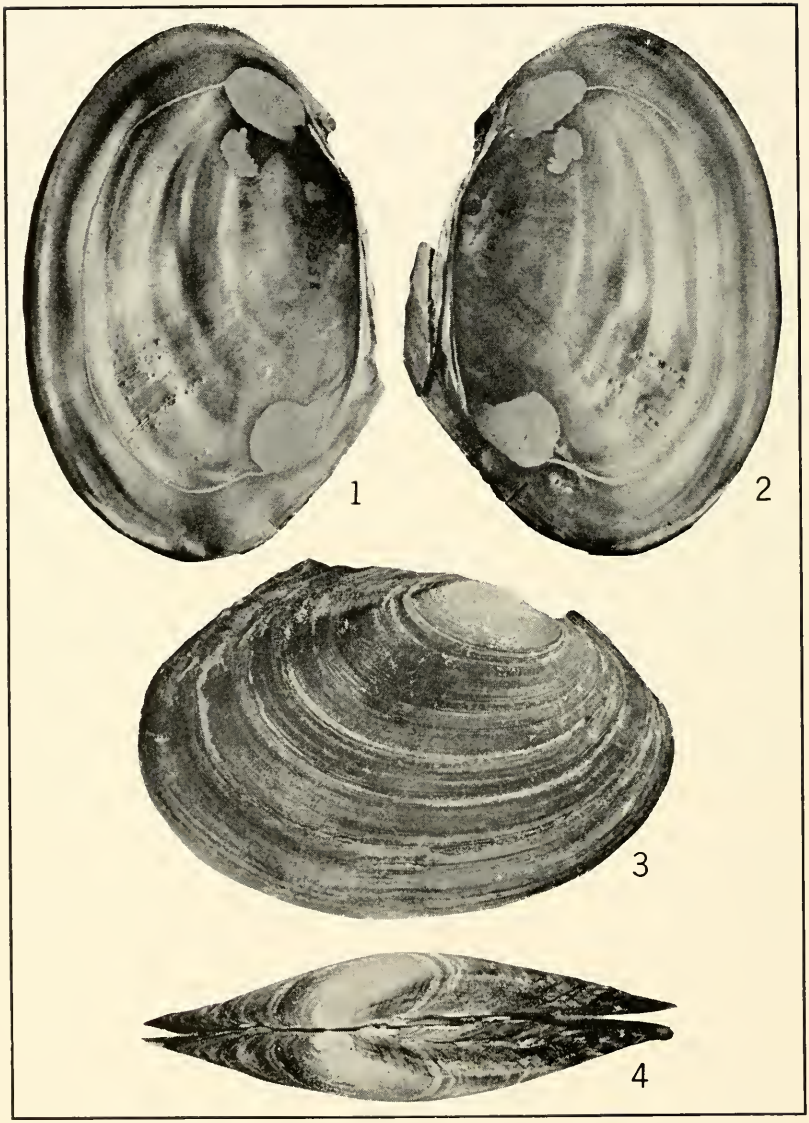
Occurrence in Kansas: L. laevissima is common in the tributaries of the Kansas River; it occurs also in the Marais des Cygnes and Neosho rivers, but it is never common there. Its range includes the eastern half of Kansas.

Records of localities of occurrence of *L. laevissima* indicate a more westerly distribution of this species than the authors have been able to confirm; westernmost localities include: Blue and Smoky Hill rivers (specimens not seen), Dickinson County; Little Arkansas River, Wichita, Sedgwick County (specimen not seen). Based on our studies, however, westernmost localities of occurrence of *L. laevissima* include: Delaware River, 4 mi. N Whiting, Jackson County (sec. 10, T. 5 S, R. 16 E); Neosho River, 2 mi. W and ½ mi. N Neosho Rapids, Lyon County (sec. 24, T. 19 S, R. 12 E).

Description of Shell: Shell elliptical, thin, compressed ventrally; slightly inflated at umbones; high triangular, thin, small anterior wing; valves gape at each end; beaks compressed, flattened, not raised above hinge line; beak sculpture of several small, nodulous broken ridges; anterior and posterior ends rounded; ventral margin convex, dorsal margin straight, exclusive of wings; posterior ridge rounded; surface having irregular growth lines raised into ridges at rest period; epidermis olive-green or yellowish-green, yellowish near beaks, polished.

Pseudocardinals feeble, thin, lamellar, diagonal to dorsal margin, slightly roughened, one or two in each valve; laterals well marked, long, thin, elevated; no interdentum; beak cavities shallow, having row of dorsal muscle scars; anterior and posterior muscle scars

PLATE 33



Leptodea laevissima (Lea), no. 10358; from Delaware River, at a place 2 mi. W and 2¾ mi. N Perry, Jefferson Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 6¼ inches.

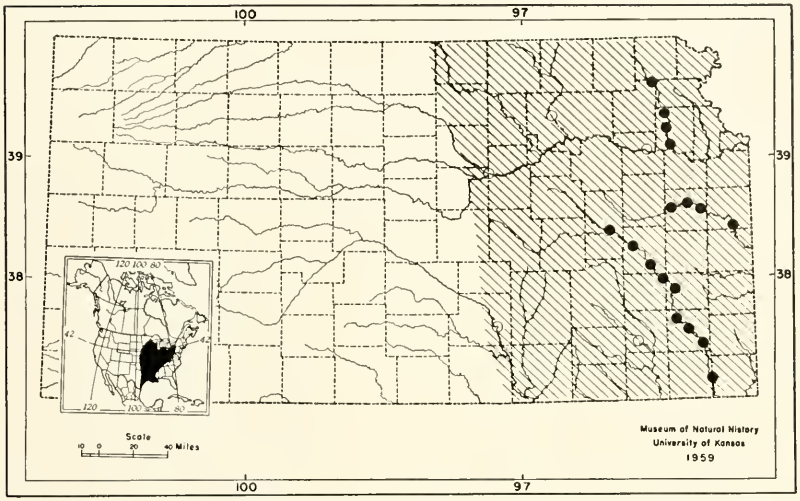


FIG. 29. Distribution of *Leptodea laevissima* in Kansas. Insert map shows the approximate distribution of this species in North America.

lightly impressed; nacre rich mauve, lighter in young shells (after Baker, 1928, p. 247).

Ecology: *L. laevissima* inhabits sand and mud bottoms of large rivers having good current (Baker, 1928, p. 248). In Kansas it is most common in areas of soft mud mixed with some sand, but occasionally occurs in rocky bottoms. It is not restricted to water with strong current, for the senior author has obtained numerous specimens from quiet pools.

Host for Glochidia: The glochidia of *L. laevissima* have been recovered from the gills of freshwater drum, *Aplodinotus grunniens* and white crappie, *Pomoxis annularis* (Surber, 1913, p. 107).

Remarks: In Kansas *L. laevissima* may be confused with *L. fragilis*. The differences between these two species are discussed under *L. fragilis*.

L. laevissima from the northern drainages in Kansas have a more highly polished epidermis than those from the southern drainages. It is not clear why *L. laevissima* replaces *L. fragilis* north of the Kansas River; *L. laevissima* may have a higher tolerance to the larger amounts of sand present in the tributaries of the Kansas River.

The highly polished, green epidermis, the beautiful mauve nacre, and the fragile nature of the shell make this one of the most beautiful of Kansas unionids. Unfortunately, because of its thinness, large

cracks usually appear in the shell when dried; consequently shells were never valued for buttons. Large specimens from Kansas range from 6 to 6½ inches in length.

Genus PROPTERA Rafinesque 1819

Shell usually large, gaping at anterior end and at edge of dorsal slope; winged along dorsal region when young, often when adult; beak sculpture of an anterior and posterior loop, the former often wanting; epidermis generally brown, clothlike, rayless or feebly rayed; pseudocardinals frequently imperfect or nearly wanting; laterals remote (after Walker, 1918, p. 71). Type: *Unio alatus* Say.

Pink Heel-Splitter Mussel

Proptera alata (Say)

Plate 34, figures 1-4; text figure 30

Unio alatus Say, 1817, Nich. Encyc., 2:(no pagination), pl. 4, fig. 2; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 119; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19.

Proptera alata, Ortmann, 1912, Ann. Carnegie Mus., 8:333; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:385.

Lampsilis alata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:299; Simpson, 1914, A descriptive catalogue . . . mussels, p. 162.

Type Locality: Lake Erie.

General Distribution: Entire Mississippi River drainage from eastern New York west to eastern Kansas, north to Wisconsin, south to Tennessee and Arkansas; Red River of the North; Ottawa, Canada (La Rocque, 1953, p. 97).

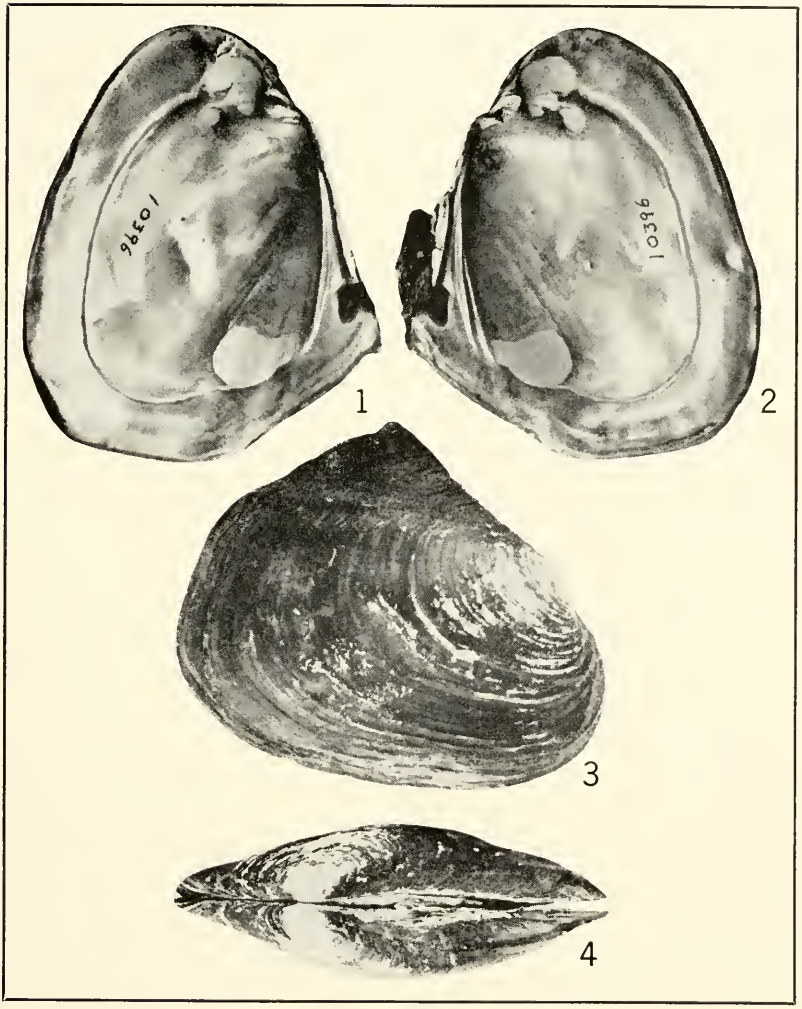
Occurrence in Kansas: Proptera alata occurs in the eastern one-half of Kansas as far north as the Kansas River. Specimens north of the Kansas River are unknown. Scammon (1906, p. 300) reported that *P. alata* occurred in Fall River; however, there have been no records from the Verdigris drainage since 1906.

The westernmost records for *P. alata* in Kansas are: Kansas River, Topeka, Shawnee County (specimen not seen); Neosho River, ½ mi. N and 3 mi. W Neosho Rapids, Lyon County (sec. 24, T. 19 S, R. 12 E).

Description of Shell: Shell thick, heavy, subovate, roughly triangular; anterior end somewhat pointed; ventral margin slightly convex; dorsal margin straight, strongly alate posteriorly; posterior margin obliquely truncated, meeting dorsal wing at sharp angle; alate border slightly concave; posterior ridge rounded, having one or two elevated lines; valves more or less compressed; beaks slightly

elevated above hinge line; beak sculptured by 3-4 fine bars; epidermis dark, brownish-green in young specimens to brownish or black in older specimens; young specimens frequently rayed; rest periods distinctly marked; shell in female slightly more broadly rounded in post-basal region than in male.

PLATE 34



Proptera alata (Say), no. 10396, ♀; from Marais des Cygnes River, at a place 2 mi. E and 1¼ mi. S Pomona, Franklin Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4½ inches.

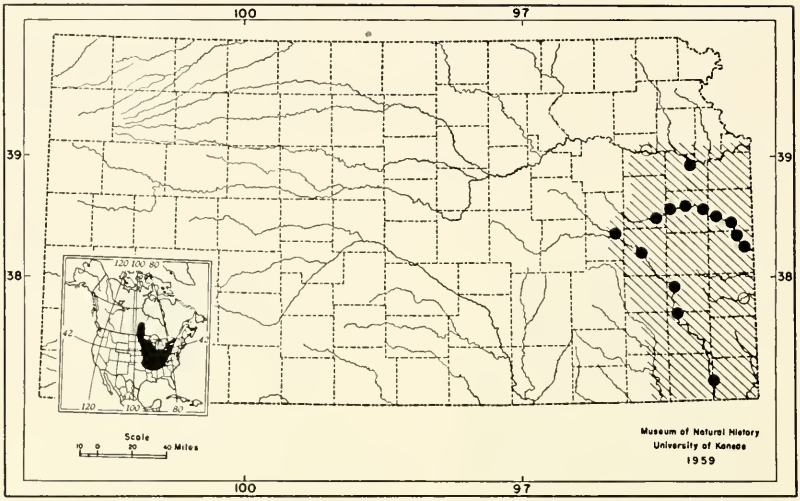


FIG. 30. Distribution of *Proptera alata* in Kansas. Insert map shows approximate distribution of this species in North America.

Pseudocardinals strong, flatly triangular, subparallel to hinge line, serrated, two in left valve, one in right valve, sometimes second tooth anterior in right valve; laterals long, almost straight, thin or lamellar; no interdentum; beak cavity shallow, having dorsal muscle scars in straight row; anterior and posterior muscle scars well marked; nacre light pink to purple, rose or salmon, iridescent posteriorly (after Baker, 1928, p. 242).

Ecology: In Kansas *P. alata* is found in the larger streams in hard or soft mud, gravel, or rocky bottoms. It may be found in swift or still water but rarely in stagnant water.

Host for Glochidia: Not recorded.

Remarks: P. alata may be confused with *P. purpurata.* The former has a higher wing, lighter and less swollen shell, and is almost square behind; *P. purpurata* is more rounded. In *P. alata* no more than one-third of the row of dorsal muscle scars is situated in the umbonal cavity. In *P. purpurata* more than one-third of the row of dorsal muscle scars is situated within the umbonal cavity. *P. alata* may also be confused with *Lasmigona complanata.* The differences between *P. alata* and *Lasmigona complanata* are discussed in the account of the latter.

Scammon (1906, p. 300) reported *P. alata* as common in the Kansas River drainages and scarce in the Marais des Cygnes and Neosho

rivers. Recent studies indicate that it is extremely abundant in the Marais des Cygnes River, common in the Neosho River and extremely rare in the Kansas River drainage.

Because of the beautiful nacre and large size, this species is valued for novelty work. It was not valued for buttons. Large specimens from Kansas range from 7 to 7½ inches in length.

Purple Shell Mussel

Proptera purpurata (Lamarck)

Plate 35, figures 1-4; text figure 31

Unio purpurata Lamarck, 1819, An. sans Vert., 6:71.

Proptera purpurata, Ortmann, 1912, Ann. Carnegie Mus., 8:334; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:117.

Lampsilis purpurata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:300; Simpson, 1914, A descriptive catalogue . . . mussels, p. 166.

Unio purpuratus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 121; Call, 1886, *op. cit.*, p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

Type Locality: "Africa!!" (Simpson, 1914, p. 167).

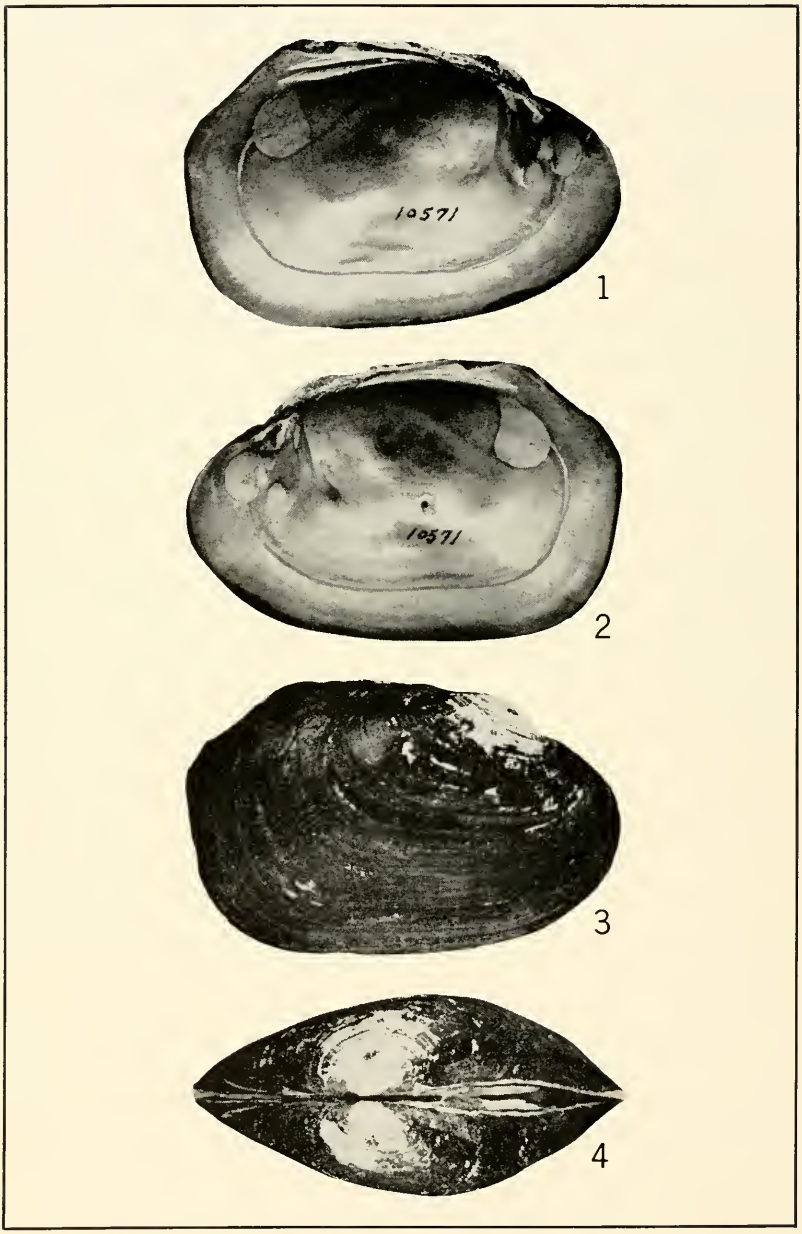
General Distribution: Southern drainages of the Mississippi River from eastern Texas north to eastern Kansas through southern Missouri and western Tennessee to the Alabama River drainage.

Occurrence in Kansas: Proptera purpurata is restricted to those streams draining the southeastern portion of Kansas. Call (1885-1887) and Scammon (1906) reported it from the Kansas and Marais des Cygnes rivers. Either they confused *P. alata* and *P. purpurata* or else *P. purpurata* has been subsequently extirpated in those rivers. Recent studies show it to be absent from the Delaware, Marais des Cygnes, and Wakarusa rivers. It is abundant in the Neosho River.

The westernmost records for *P. purpurata* in Kansas are: Neosho River, 2½ mi. W Americus, Lyon County (sec. 9, T. 18 S, R. 10 E); Little Arkansas River, Wichita, Sedgwick County (specimen not seen).

Description of Shell: Shell large, somewhat obovate, inflated, solid, heavy; beaks full, high, having faint, corrugated sculpture; scarcely winged anteriorly; low, angular wing posteriorly, having 2-3 low, radiating ridges on posterior slope, surface nearly smooth, having shining, blackish epidermis; ligament large, long, exposed in adults; shell of female wide, rounded, marsupial swelling posteriorly, more truncated posteriorly than in male.

PLATE 35



Proptera purpurata (Lamarck), no. 10571, ♀; from Neosho River, ¼ mi. S of the dam at Humboldt, Allen Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4⅛ inches.

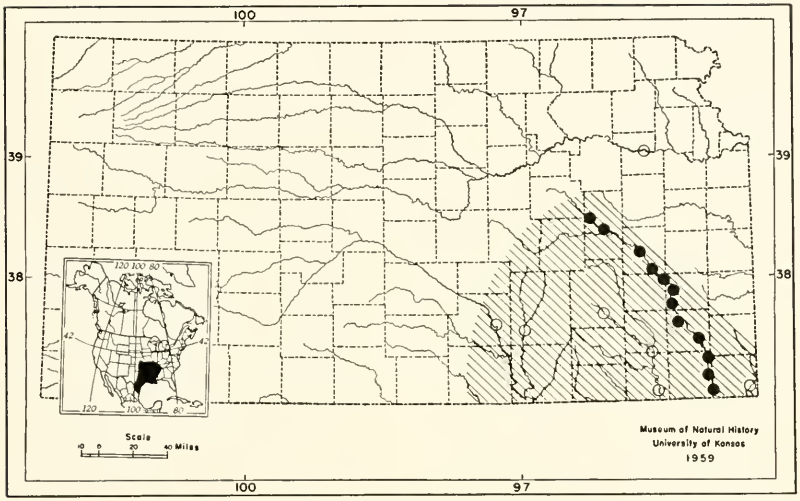


FIG. 31. Distribution of *Proptera purpurata* in Kansas. Insert map shows approximate distribution of this species in North America.

Two, subcompressed, ragged, elevated pseudocardinals in left and right valves, lower pseudocardinal of right valve the larger; laterals long, high, truncated in right valve; beak cavities deep having row of dorsal muscle scars; anterior muscle scar deep; posterior muscle scars scarcely impressed; nacre rich, dark, purple, iridescent posteriorly (after Simpson, 1914, p. 166).

Ecology: *P. purpurata* inhabits streams of deep water having deep mud and fairly quiet pools.

Host for Glochidia: Glochidia occur on the gills of *Aplodinotus grunniens*, the freshwater drum (Surber, 1915, p. 6).

Remarks: In Kansas, *P. purpurata* can be confused with *P. alata*. The differences are discussed under *P. alata*. *P. purpurata* replaces *P. alata* in the southern drainages where the former is extremely common.

This is a beautiful shell and usually lacks blemishes on the nacre. Because of its purple color, it was not valued for buttons, but rather for novelties. In a novelty store in Kansas City, Missouri, in 1959, *P. purpurata* was being sold for 15 cents a half shell! Large Kansas specimens range from 6½ to 6¾ inches in length. This is approximately ½ inch longer than the largest specimen reported from Kansas by Call (1887, p. 22).

Pocketbook Mussel

Proptera capax (Green)

Plate 36, figures 1-4; text figure 32

Unio capax Green, 1832, Cab. Nat. Hist., 2:290.
Proptera capax, Ortmann, 1914, Nautilus, 28:67.
Lampsilis capax, Simpson, 1914, A descriptive catalogue . . . mussels, p. 47.

Type Locality: Falls of St. Anthony, Minnesota.

General Distribution: The Mississippi River drainage from southern Wisconsin south to northern Arkansas and from eastern Tennessee west to eastern Kansas.

Occurrence in Kansas: One female of *Proptera capax* was recovered by Harold Murray on 27 August, 1956 from the Neosho River, 7½ mi. E and 1 mi. S Emporia, Lyon County, Kansas (sec. 24, T. 19 S, R. 12 E). This is the first record of *P. capax* in Kansas. The previous westernmost records were the St. Francis River, Arkansas, and two almost certainly invalid records from the Elkhorn and the Blue rivers, Nebraska (Simpson, 1914, p. 47).

Description of Shell: Shell greatly inflated, obovate, subsolid, gaping at both ends; anterior end sharply rounded; dorsal margin curved; ventral margin straight, curving sharply into ends; umbones elevated, greatly inflated; posterior ridge full, rounded, having excavated or flattened area posteriorly; shell alate anteriorly; ligament strong, passing forward under beaks forming a long lunule; surface smooth, more or less shining; epidermis yellowish or reddish-brown, more or less smoky, rayless; shell of female slightly more inflated in post-basal region than that of male.

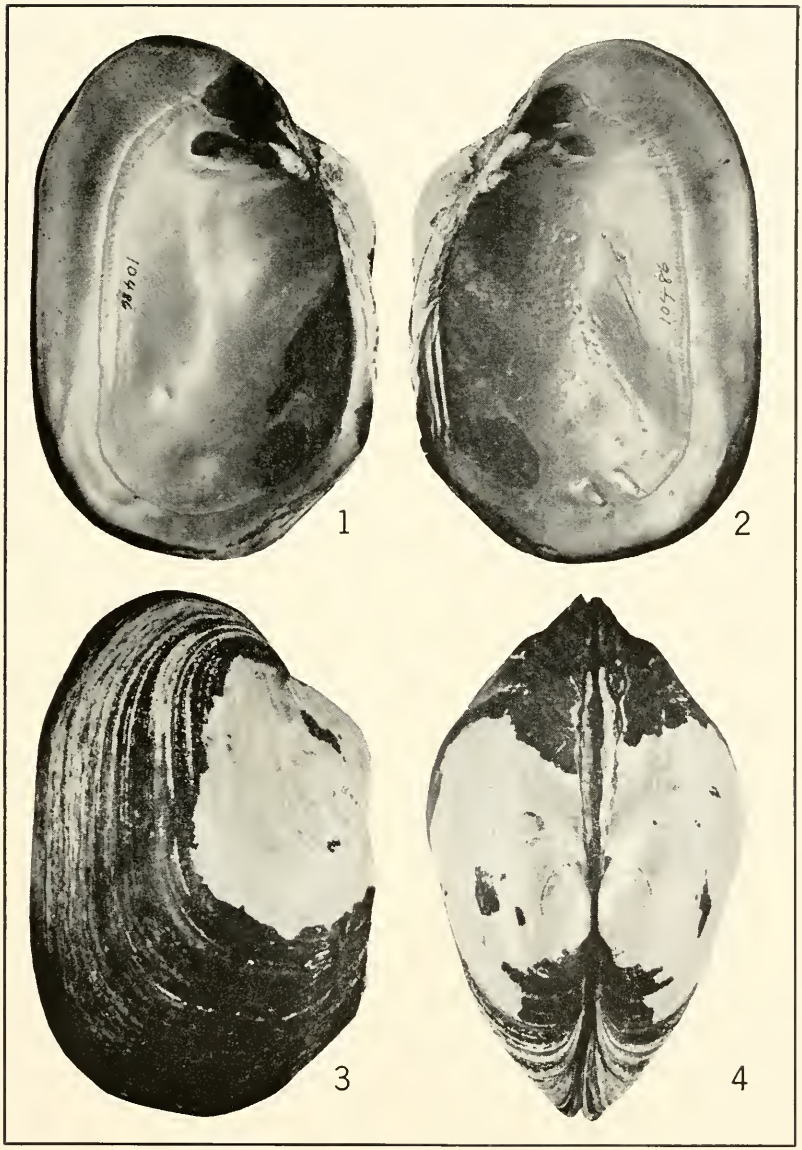
Pseudocardinals of left valve more or less double, thin, compressed, elevated, sulcate, before beaks; pseudocardinals of right valve double, erect, compressed; all pseudocardinals parallel to hinge line; laterals short, erect, curved, double in left, single in right valve; beak cavities deep, wide; anterior muscle scars well impressed; posterior muscle scars faintly impressed; nacre bluish white, pinkish, or salmon tinted (after Baker, 1928, p. 249).

Ecology: The single specimen known in the state occurred in slowly moving water 3½ feet deep in a substrate of cobble, sand, and very little silt.

Host for Glochidia: Not recorded.

Remarks: The specimen from Kansas has a somewhat darker

PLATE 36



Proptera capax (Green), no. 10486, ♀; from Neosho River, at a place ½ mi. N and 3 mi. W Neosho Rapids, Lyon Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, left valve; fig. 4, dorsal aspect of shell. Actual length, 6 1/16 inches.

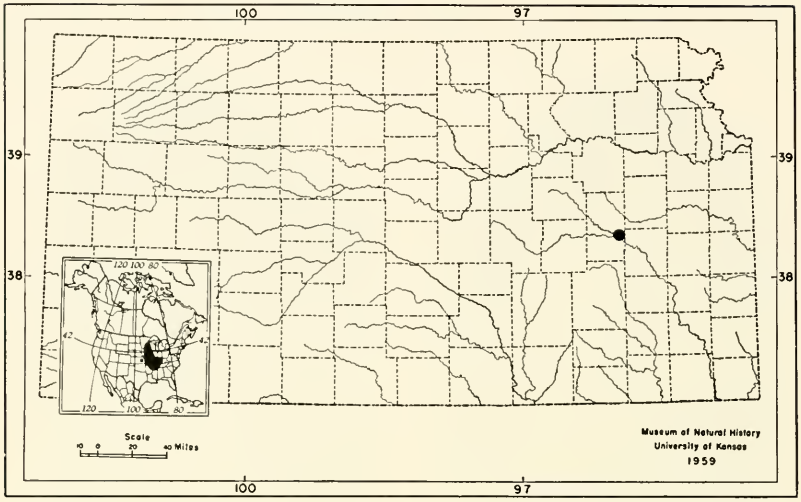


FIG. 32. Known occurrence of *Proptera capax* in Kansas. Insert map shows approximate distribution of this species in North America.

purple nacre, and the shell is somewhat more elongate than typical specimens from the Mississippi River.

P. capax is unknown in the area between the Neosho River and the Mississippi River.

P. capax was never valued for buttons. The Kansas specimen measures 155 mm. (approximately 6⅛ inches) in length, 88 mm. wide, and 101 mm. high. In length this specimen exceeds the previously reported maximum length of *P. capax* by 12 mm. (Haas, 1941, p. 261).

Genus CARUNCULINA (in Baker) Simpson 1898

Shell small, inflated, obovate, rather solid, having thick, dark, rayless or feebly rayed epidermis; beak sculpture of strong, concentric ridges forming a single rounded loop in front, strongly curved upward behind; female truncated obliquely in post-basal region; pseudocardinals compressed, smooth on inside, reflected upwards, somewhat ragged on edges (after Walker, 1918, p. 76). Type: *Unio parvus* Barnes.

Lilliput Mussel

Carunculina parva (Barnes)

Plate 37, figures 1-4; text figure 33

Unio parvus Barnes, 1823, Amer. Jour. Sci., 6:274, pl. 13, fig. 18; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 120; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

Carunculina parva, Utterback, 1916, Amer. Midl. Nat., 4:164; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:384.

Lampsilis parvus, Scammon, 1906, Univ. Kansas Sci. Bull., 3:298; Simpson, 1914, A descriptive catalogue . . . mussels, p. 151.

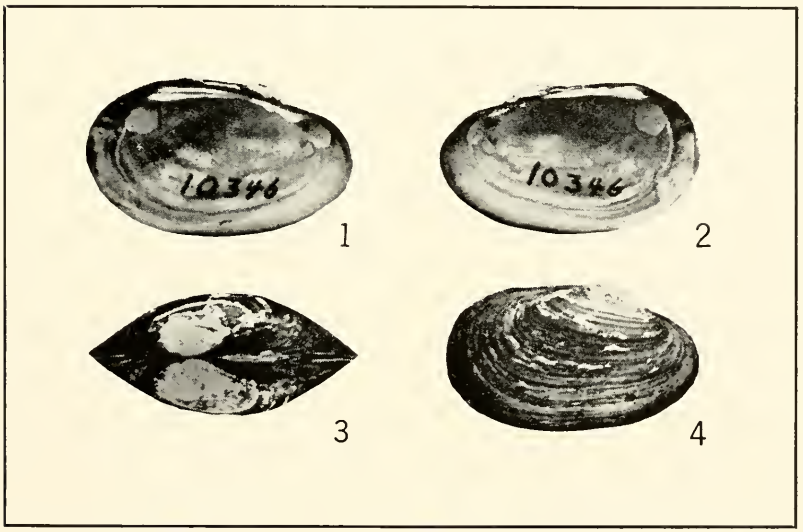
Type Locality: Fox River, Wisconsin.

General Distribution: Entire Mississippi River drainage from western New York, west to Iowa, eastern Kansas, and central Texas, north to southern Canada and Michigan, south to Louisiana (Baker, 1928, p. 253).

Occurrence in Kansas: Carunculina parva is common throughout the eastern one-fourth of Kansas. It has been reported from south-central Kansas where it is extremely rare.

The westernmost records for *C. parva* in Kansas are: Delaware River, 8 mi. W and 3½ mi. N Horton, Brown County; Big Creek,

PLATE 37



Carunculina parva (Barnes), no. 10346, ♀; from Delaware River, 8 mi. W and 3½ mi. N Horton, Brown Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, dorsal aspect of shell; fig. 4, exterior, right valve. Actual length, 1¼ inches.

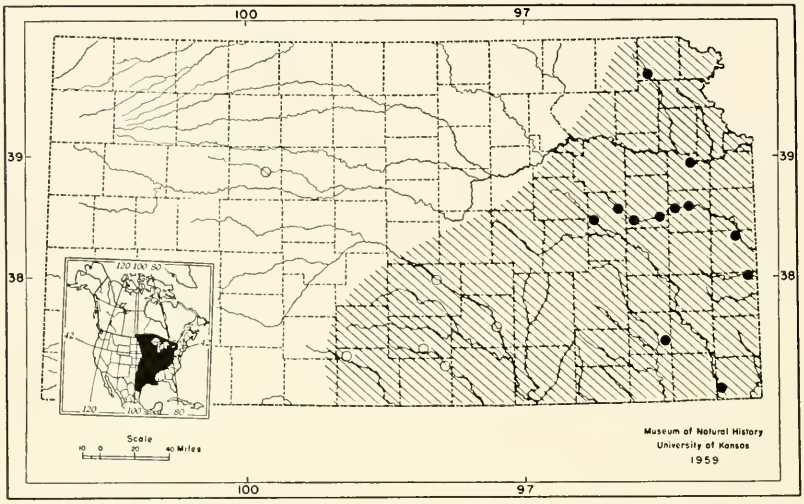


FIG. 33. Distribution of *Caruncilina parva* in Kansas. Insert map shows approximate distribution of this species in North America.

Ellis County (specimen not seen); Turkey Creek, Barber County (specimen not seen).

Description of Shell: Shell small, rather solid, subelliptical, somewhat inflated; anterior and posterior ends rounded; ventral margin straight or slightly convex; dorsal margin straight, almost parallel to ventral margin; posterior ridge absent; posterior slope somewhat flattened and compressed; beaks slightly elevated above hinge line, somewhat inflated; beak sculpture consisting of 5-6 distinct, subconcentric bars, last 3-4 bars forming blunt angle posteriorly; epidermis unusually thick, usually dark brown or black, rayless, growth lines usually coarse and slightly elevated; shell somewhat more swollen in female than in male, having greatest height at posterior end of shell.

Two rough, triangular, compressed, erect, pseudocardinals in left valve, one in right valve; laterals straight, rather strong, erect, rough; no interdentum; beak cavities deep, containing dorsal muscle scars in a diagonal row, pointed anteriorly; anterior adductor muscle scar deeply impressed, posterior muscle scar not distinct; nacre silvery white, more or less iridescent, some specimens having tinge of pinkish-yellow near beak cavities (after Baker, 1928, p. 251).

Ecology: C. parva is found most often in small streams having sluggish current and mud bottom (Baker, 1928, p. 253). The species

frequently occurs near the banks of large streams in water no more than 2 to 3 inches deep.

Host for Glochidia: Not recorded.

Remarks: In Kansas *C. parva* may be confused with small examples of *Ligumia subrostrata*. *C. parva* can be distinguished by its smaller size, its darker brown to black epidermis, its more rounded posterior end, and the presence of prominent half circled ridges on the beak. Sculpturing on the beak of *L. subrostrata* consists of numerous inverted V's.

This is the smallest of the Kansas unionids. Because of its small size and fragile shell, it was never used for buttons. In some suitable habitat as many as 100 individuals occur within a radius of a few feet. Large specimens from Kansas range from 1 to 1⅛ inches in length.

Genus Ligumia Swainson 1840

Shell oval to oblong; surface smooth; beak sculpture delicate, double looped; shell of female more or less expanded or swollen in the post-basal region (after Walker, 1918, p. 76). Type: *Unio recta* Lamarck.

Black Sand Mussel

Ligumia recta latissima (Rafinesque)

Plate 38, figures 1-4; text figure 34

Unio latissima Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:297, pl. 30, figs. 14, 15.

Ligumia recta latissima, Ortmann and Walker, 1922, Occas. Papers Mus. Zool. Univ. Michigan, no. 112, p. 53.

Unio rectus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.,* p. 96; Call, 1885, *op. cit.,* p. 120; Call, 1886, *op. cit.,* p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

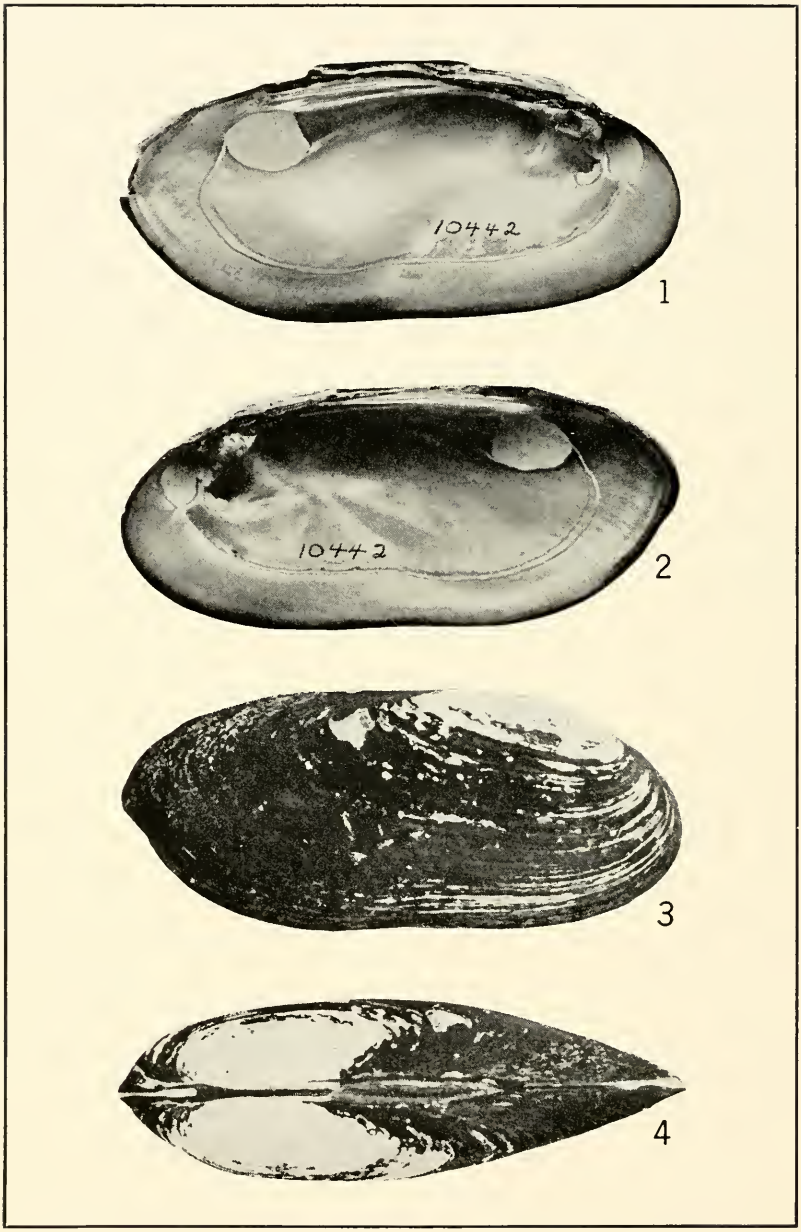
Lampsilis recta, Scammon, 1906, Univ. Kansas Sci. Bull., 3:294; Simpson, 1914, A descriptive catalogue . . . mussels, p. 95.

Type Locality: Ohio River.

General Distribution: Throughout the Mississippi River drainage from western New York west to South Dakota and Kansas, north from Minnesota south to Louisiana, Alabama and Georgia; Manitoba, Ontario, and Quebec, Canada.

Occurrence in Kansas: Restricted to the drainages of southeastern Kansas. Although there are no valid records from the Neosho River, *Ligumia recta latissima* is thought to occur there. Inasmuch as *L. r. latissima* is extremely rare in Kansas, distribution records

PLATE 38



Ligumia recta latissima (Rafinesque), no. 10442, ♀; from Marais des Cygnes River, ½ mi. N and 2 mi. W La Cygne, Linn Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 5¼ inches.

to date for the state probably do not show the actual geographic range.

The westernmost valid records for *L. r. latissima* in Kansas are: Marais des Cygnes River, Franklin County; Elk River, 1 mi. S Howard, Elk County (sec. 12, T. 30 S, R. 10 E).

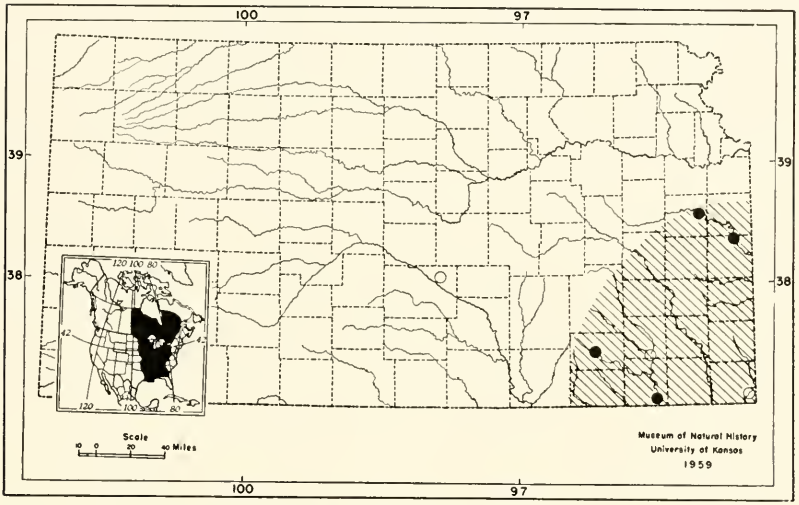


FIG. 34. Distribution of *Ligumia recta latissima* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

Description of Shell: Shell large, elongated, subelliptical, in some individuals lanceolate, longer than high, valves flattened; anterior end rounded; ventral margin straight or slightly convex; dorsal margin straight forming a pointed posterior end; posterior slope faintly indicated near beaks, rounded, low below; beaks low, scarcely raised above hinge line, sculptured by 3-5 faint doubly looped bars; epidermis more or less shining brown to black, sometimes rayed; shell of female having inflated post-basal region.

Pseudocardinals irregular, compressed, serrated, somewhat triangular, two in left, one in right valve; laterals long, straight, elevated, crenulated; no interdentum; beak cavity shallow, having dorsal muscle scars under hinge line; anterior muscle scars well impressed; posterior muscle scars faintly impressed; nacre usually dark purple, mauve, or white, iridescent posteriorly (after Baker, 1928, p. 255).

Ecology: L. r. latissima is typically found in large rivers in gravelly bottoms in strong currents (Baker, 1928, p. 259).

Host for Glochidia: The glochidia occur on the gills of bluegill, *Lepomis macrochirus* and white crappie, *Pomoxis annularis* (Surber, 1913, p. 109; Coker, *et al.*, 1921, p. 153).

Remarks: In Kansas *L. r. latissima* may be confused with *Elliptio dilatatus*, but in the latter the hinge teeth are not pointed, there is an interdentum, the posterior end is less pointed, and the posterior ridge descends abruptly at the posterior margin.

Scammon (1906, p. 295) reported that this species was common in the Marais des Cygnes River and rivers of more southern drainage. Recent studies in these same areas indicate that it is now extremely rare. The increased turbidity of the water in recent years may account for the decline.

The purple nacre of *L. r. latissima* is the most beautiful of that of all Kansas unionids. The drying qualities of the shell are excellent. The shell of *L. r. latissima* was rarely used for buttons; only relatively solid shells having white nacre were utilized. Large specimens from Kansas range from 5½ to 6 inches in length.

Common Pond-Mussel

Ligumia subrostrata (Say)

Plate 39, figures 1-4; text figure 35

Unio subrostratus Say, 1831, New Harmony Disseminator, Jan. 15 (no pagination); Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:94; Call, 1885, *op. cit.*, p. 122; Call, 1886, *op. cit.*, p. 182; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:23.

Ligumia subrostrata, Grier and Mueller, 1922, Nautilus, 36:100; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:382; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:117.

Unio topekaensis, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50.

Lampsilis subrostrata, Scammon, 1906, Univ. Kansas Sci. Bull., 3:295; Simpson, 1914, A descriptive catalogue . . . mussels, p. 99.

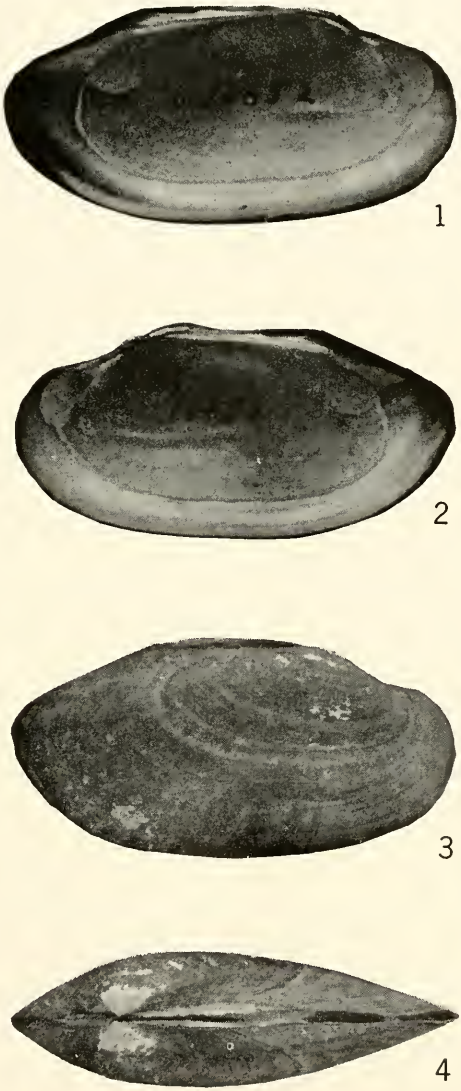
Type Locality: Wabash River.

General Distribution: Entire Mississippi River drainage as far north as Fountain City, Wisconsin, and eastern South Dakota (Simpson, 1914, p. 99; Grier and Mueller, 1922, p. 100; Over, 1942, p. 5).

Occurrence in Kansas: Ligumia subrostrata occurs in the eastern one-half of Kansas. The absence of records of occurrence from the Republican and Blue rivers in northern Kansas is probably related to inadequate collecting in those streams.

The westernmost records for *L. subrostrata* in Kansas are: Delaware River, 8 mi. W and 3½ mi. N Horton, Brown County (sec. 27, T. 17 S, R. 13 E); Marais des Cygnes River, 2½ mi. W and 3½ mi. N

PLATE 39



Ligumia subrostrata (Say), no. 10652, ♂; from Potter Lake, University of Kansas Campus, Lawrence, Douglas Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 2¼ inches.

Miller, Lyon County (sec. 1, T. 16 S, R. 12 E); Neosho River, 3½ mi. W and 2½ mi. N Americus, Lyon County (sec. 29, T. 17 S, R. 10 E); Whitewater River, ½ mi. W Towanda, Butler County (sec. 8, T. 26 S, R. 4 E); Little Arkansas River, Wichita, Sedgwick County (specimen not seen).

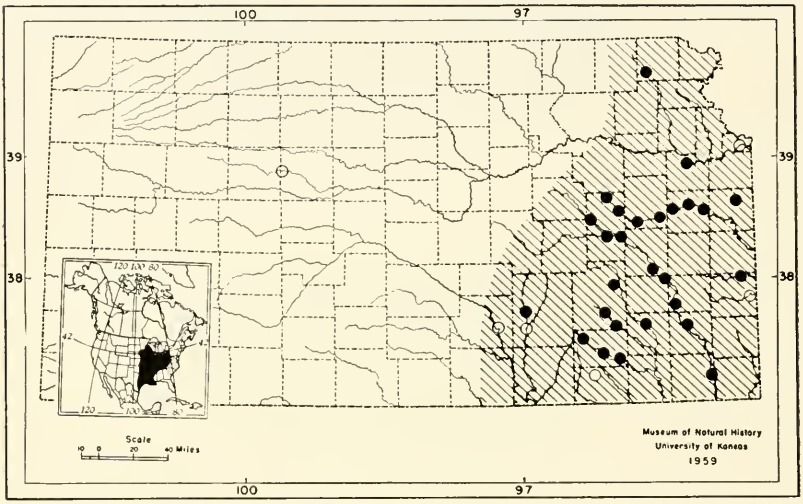


FIG. 35. Distribution of *Ligumia subrostrata* in Kansas. Insert map shows approximate distribution of this species in North America.

Description of Shell: Shell elongate, irregularly elliptical, subsolid, somewhat inflated; beaks full, having numerous delicate ridges drawn up in middle; slightly winged; rounded anteriorly; pointed posteriorly; posterior ridge moderately developed; surface dull, dirty greenish-yellow, generally having faint, wide rays on posterior portion, often having concentric bands of lighter and darker color; shell of female narrowed in front, having large, rounded post-basal swelling; base line incurved anterior to swelling; dorsal and ventral lines of shell of male nearly parallel forming sharp point posteriorly.

Pseudocardinal teeth compressed, two in each valve, upper in right valve smaller; one, lamellar lateral in right valve, two in left valve; posterior and anterior muscle scars shallow; beak cavities moderate; nacre bluish-white, rarely thicker anteriorly (after Simpson, 1914, p. 99).

Ecology: L. subrostrata occurs abundantly in ponds and creeks in soft to hard mud. It is rarely found in rocky bottoms. In the larger streams it may be abundant locally, but always in shallow

pondlike areas of the river. In June, 1958, the one-acre Potter Lake on the University of Kansas Campus, Lawrence, Douglas Co., Kansas, was drained. 2,178 living unionids representing 4 species were removed from the pond. *L. subrostrata* accounted for 1,517 (approximately 70 per cent) of the living specimens (Murray, 1960).

Host for Glochidia: Not recorded.

Remarks: L. subrostrata may be confused with immature *Uniomerus tetralasmus,* several species of the genus *Lampsilis,* and the adults of *Carunculina parva. L. subrostrata* may be readily distinguished from these species by the presence of numerous ridges on the umbones in the shape of V's having the open ends spread widely apart.

Because of its small and fragile shell, *L. subrostrata* was not valued for buttons. Large specimens from Kansas range from 3 to 3¼ inches in length.

Genus Lampsilis Rafinesque 1820

Shell oval to elliptical, smooth or slightly, concentrically sculptured, usually without posterior ridge; epidermis generally smooth, shining, often rayed; beak sculpture of double-looped, parallel ridges, having posterior loop open behind or sculpture obsolete; hinge having one or two pseudocardinals; only lateral in right valve; two pseudocardinals, two laterals in left valve; female shell having strong inflation of shell, dilation in post-basal region, forming distinct posterior truncation of shell (after Walker, 1918, p. 78). Type: *Unio ovatus* Say.

Yellow Sand-Shell Mussel

Lampsilis anodontoides anodontoides (Lea)

Plate 40, figures 1-4; text figure 36

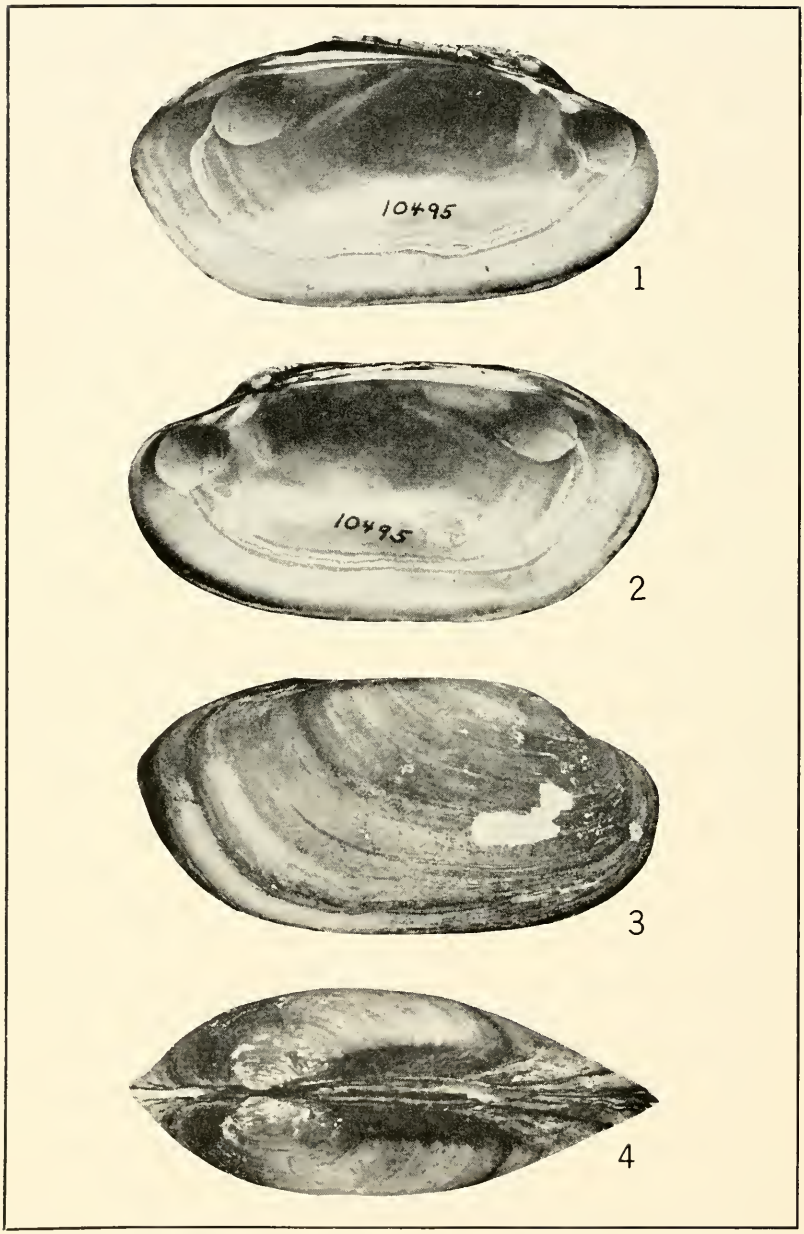
Unio anodontoides Lea, 1834, Trans. Amer. Phil. Soc., 4:81, pl. 8, fig. 11; Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.,* p. 96; Call, 1885, *op. cit.,* p. 119; Call, 1886, *op. cit.,* p. 180; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:19.

Lampsilis anodontoides, Baker, 1898, Bull. Nat. Hist. Surv., Chicago Acad. Sci., Pt. 1, p. 100; Scammon, 1906, Univ. Kansas Sci. Bull., 3:291; Clark and Gillette, 1911, Proc. Biol. Soc. Washington, 24:68; Simpson, 1914, A descriptive catalogue . . . mussels, p. 90; Franzen and Leonard, 1946, Univ. Kansas Sci. Bull., 31:117.

Type Locality: Mississippi, Alabama, and Ohio rivers.

General Distribution: Entire Mississippi River drainage north as far as eastern South Dakota (Vermillion River), south as far as northern Mexico; all of the Gulf drainages from the Withlacoochee River, Florida, to the Rio Grande River (Baker, 1928, p. 267; Over,

PLATE 40



Lampsilis anodontoides anodontoides (Lea), no. 10495, ♀; from Neosho River, ½ mi. N and 3 mi. W Neosho Rapids, Lyon Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4⅜ inches.

1942, p. 5). Distribution includes *Lampsilis anodontoides fallaciosa.*

Occurrence in Kansas: Lampsilis anodontoides anodontoides inhabits primarily the streams draining southeastern Kansas. It is common in the Marais des Cygnes and Neosho rivers and rare in other southeastern Kansas streams. This species may occur as isolated populations in small streams in various parts of the state. It is occasionally found in the Wakarusa River, Douglas County.

The westernmost records for *L. a. anodontoides* are: Neosho River, 2½ mi. W Americus, Lyon County (sec. 9, T. 18 S, R. 10 E); Ninnescah River, Reno County (specimen not seen).

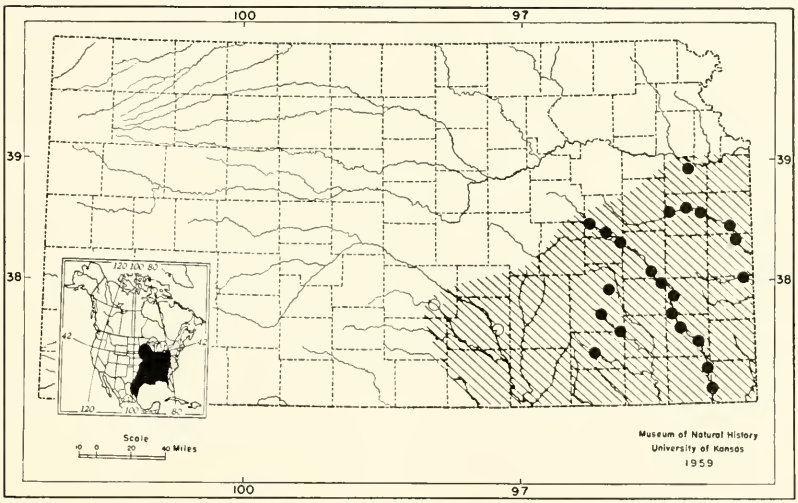


FIG. 36. Distribution of *Lampsilis anodontoides anodontoides* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

Description of Shell: Shell large, thick, elongated, somewhat inflated; gaping at both ends; anterior end rounded; posterior end pointed; dorsal and ventral margins straight, nearly parallel; posterior ridge rounded, low; beaks full, not greatly elevated above hinge line; epidermis smooth, shining, greenish-yellow or straw-colored, lacking rays; beak region frequently reddish or brownish; female having conspicuous swelling behind center of ventral border.

Two compressed pseudocardinals in each valve, anterior one elongate, posterior one elevated, serrated; laterals long, lamellar, nearly straight, roughened; no interdentum; beak cavities shallow having dorsal muscle scars; anterior and posterior muscle scars well

marked; nacre silvery-white, sometimes cream-colored or pinkish in beak cavity, iridescent posteriorly (after Baker, 1928, p. 266).

Ecology: In Kansas *L. a. anodontoides* occurs in large and small streams, in slow and fast moving water, in rocky and muddy bottoms, and in shallow and deep water, but it does not occur in shifting sand bottoms.

Host for Glochidia: The following fish have been recorded as naturally infected: long-nosed gar, *Lepisosteus osseus;* green sunfish, *Lepomis cyanellus;* orange-spotted sunfish, *L. humilis;* large-mouthed bass, *Micropterus salmoides;* white crappie, *Pomoxis annularis;* black crappie, *P. nigromaculatus* (Baker, 1928, p. 267).

Remarks: It is not possible to distinguish between *L. a. anodontoides* and *L. a. fallaciosa* in the records by Call (1885-1887). Because most of his localities are duplicated in later records at our museum, no attempt has been made to place his localities on the distribution map, figure 36.

L. a. anodontoides may be distinguished from *L. a. fallaciosa* by its shell being somewhat larger, less cylindrical and, having a yellowish, usually rayless epidermis. As would be expected with intergrades, there are examples in the eastern portion of the Marais des Cygnes River and southern portion of the Neosho River that are difficult to assign to one or the other subspecies. *L. a. anodontoides* may be confused with *L. radiata siliquoidea,* but the latter is more rounded posteriorly and the shell is wider and heavier.

The beautiful smooth nacre and even thickness of the shell make this the most prized of unionids for buttons. The drying qualities of the shell are excellent. Older specimens frequently have the periostracum eroded from the umbonal area. Large specimens from Kansas range from 4½ to 5 inches in length.

Slough Sand Mussel

Lampsilis anodontoides fallaciosa Smith

Plate 41, figures 1-2; text figure 37

Lampsilis fallaciosus Smith, 1899, Bull. U. S. Fish Comm., p. 291, pl. 79 (no description); Simpson, 1900, Proc. Acad. Nat. Sci., Philadelphia, p. 74, pl. 2, fig. 5; Scammon, 1906, Univ. Kansas Sci. Bull., 3:293; Simpson, 1914, A descriptive catalogue . . . mussels, p. 92.

Lampsilis anodontoides fallaciosa, Grier and Mueller, 1926, Bull. Wagner Free Inst. Sci. Philadelphia, 1(23):18.

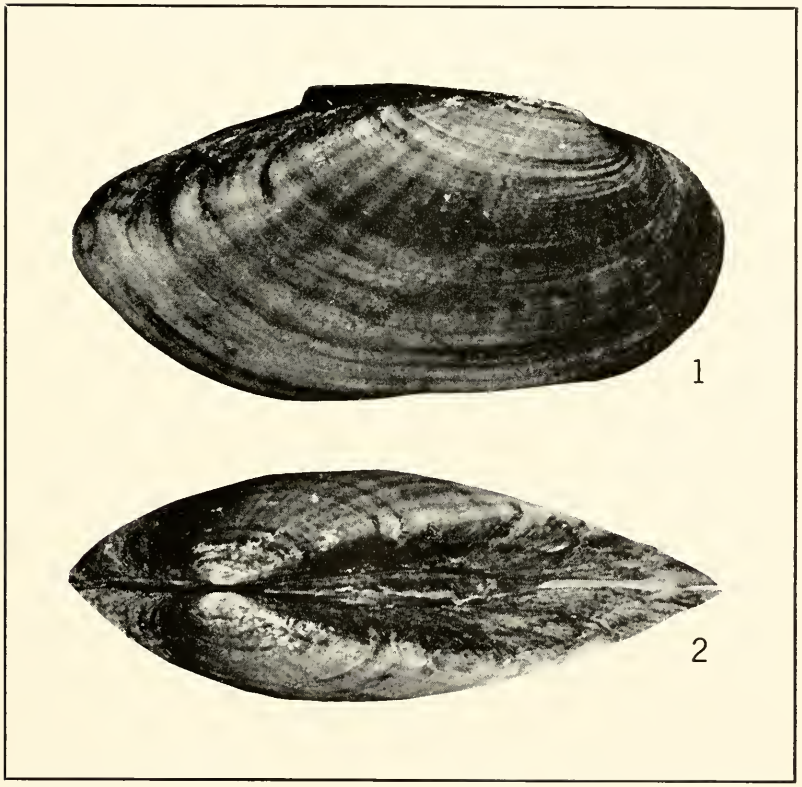
Type Locality: Not given.

General Distribution: Simpson (1914, p. 92) states that *Lampsilis anodontoides fallaciosa* occurs in the "upper Mississippi drainage,

south to the Cumberland River, Tennessee and to Arkansas; Red River of the North?" Inasmuch as La Rocque (1953) does not record *L. a. fallaciosa* from the Red River of the North, it seems unlikely that the questionable locality of Simpson is valid.

Occurrence in Kansas: *L. a. fallaciosa* may have a wider range in Kansas than the distribution map (figure 37) indicates. Because *L. a. fallaciosa* is often confused with *L. a. anodontoides*, it is not always possible to distinguish one from the other in the literature. Validated occurrences indicate a range in the extreme eastern portion of the Kansas and Marais des Cygnes rivers and the extreme southern portion of the Neosho River, but *L. a. fallaciosa* probably occurs elsewhere in the state.

PLATE 41



Lampsilis anodontoides fallaciosa Smith, no. 10647, ♀; from Neosho River, ¼ mi. E Chetopa, Labette Co., Kansas. Fig. 1, exterior, right valve; fig. 2, dorsal aspect of shell. Actual length, 3¾ inches.

The westernmost records for *L. a. fallaciosa* in Kansas are: Wakarusa River, Douglas County; Marais des Cygnes River, 5½ mi. E Osawatomie, Miami County (sec. 10, T. 18 S, R. 23 E); Neosho River, ¼ mi. E Chetopa, Labette County (sec. 35, T. 34 S, R. 21 E).

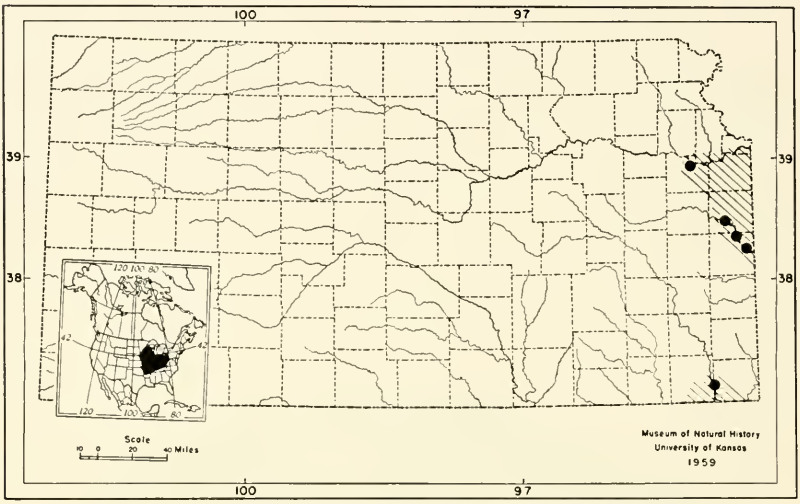


FIG. 37. Distribution of *Lampsilis anodontoides fallaciosa* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

Description of Shell: Shell as in *L. a. anodontoides* except more elongate and more cylindrical; epidermis of *L. a. fallaciosa* smoothish, greenish-yellow and having dark green rays covering greater part of shell; young specimens bright greenish-yellow having grass-green rays (rays absent in *L. a. anodontoides*).

Ecology: According to Baker (1928, p. 269) this subspecies typically is found in muddy sloughs or pondlike areas of streams. This is not true in Kansas, where the subspecies usually occurs in rocky areas in streams having a moderate current.

Host for Glochidia: The glochidia have been observed on the gills of white crappie, *Pomoxis annularis;* sturgeon, *Scaphirhynchus platorhynchus;* short-nosed gar, *Lepisosteus platostomus* (Baker, 1928, p. 269).

Remarks: Some authors (Baker, 1928; Simpson, 1914) have treated *fallaciosa* as a species, but recent authors (Goodrich and van der Schalie, 1944; van der Schalie and van der Schalie, 1950) have considered *fallaciosa* as a subspecies of *anodontoides.*

In Kansas intergradation of *fallaciosa* and *anodontoides* occurs

near the eastern and southern borders of the state. Specimens collected in those areas are not typical *fallaciosa* when compared to those of the upper Mississippi drainage. They are less distinctly rayed, and some examples are difficult to distinguish from *anodontoides*, as might be expected. Utterback (1916a, p. 181) reported that *anodontoides* is supplanted by *fallaciosa* in the upper Osage River; therefore it is not clear why *anodontoides* should replace *fallaciosa* in the upper Marais des Cygnes drainage (Osage River in Missouri). Ecological stress factors may account for this distribution; however, additional data are needed in order to clarify the situation.

The distinguishing features and economic value of *L. a. fallaciosa* are discussed in the account of *L. a. anodontoides*.

Fat Mucket Mussel

Lampsilis radiata siliquoidea (Barnes)

Plate 42, figures 1-4; text figure 38

Unio siliquoides Barnes, 1823, Amer. Jour. Sci., 6:269, pl. 13, fig. 15.

Lampsilis radiata siliquoidea, Clarke and Berge, 1959, Memoir, New York State College Agriculture, no. 365, p. 60.

Lampsilis siliquoidea, Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., 29:379; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:117.

Lampsilis luteola, Scammon, 1906, Univ. Kansas Sci. Bull., 3:287; Simpson, 1914, A descriptive catalogue . . . mussels, p. 60.

Unio luteolus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.*, p. 96; Call, 1885, *op. cit.*, p. 120; Call, 1886, *op. cit.*, p. 181; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:21.

Type Locality: Wisconsin River.

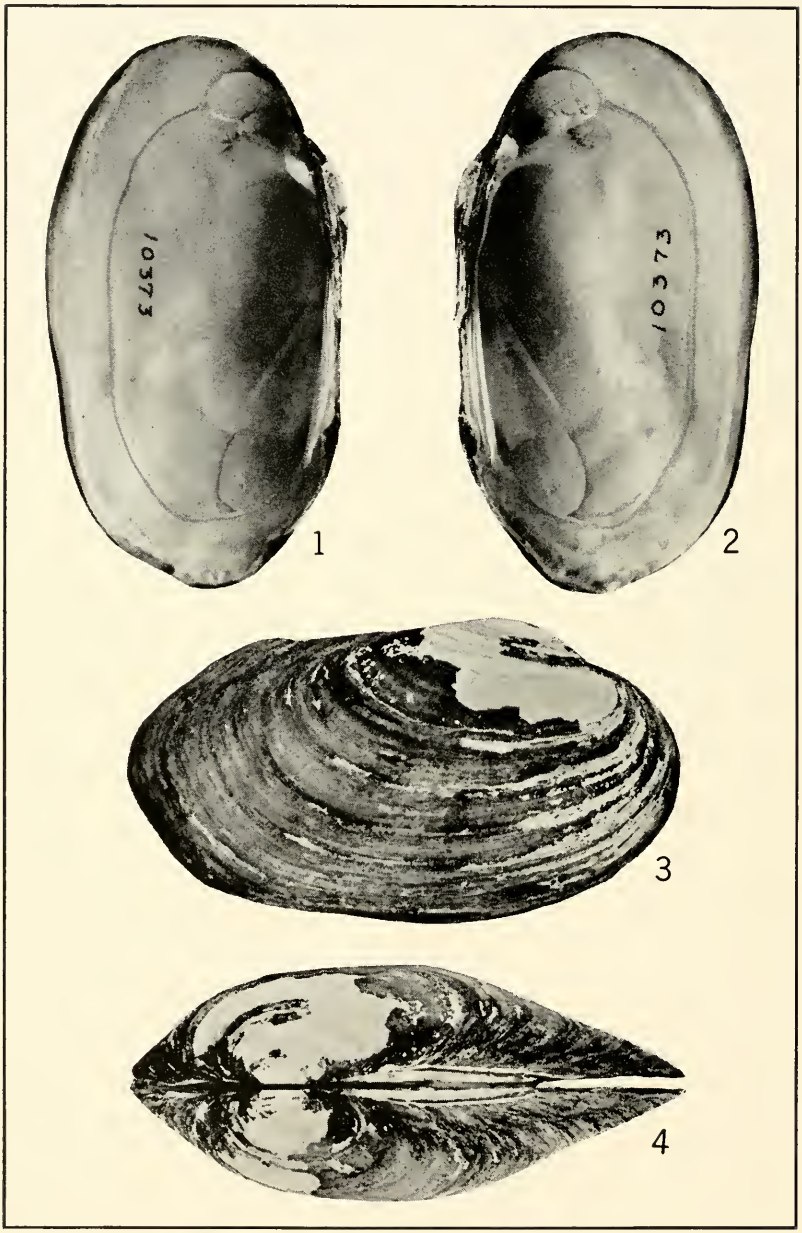
General Distribution: Entire Mississippi Valley, from western New York west to North Dakota and Texas, from Louisiana north to Wisconsin and Minnesota; all of Canada east of the Rocky Mountains (Ortmann, 1919, p. 289; La Rocque, 1953, p. 93).

Occurrence in Kansas: Lampsilis radiata siliquoidea occurs in the eastern one-half of Kansas, except north of the Kansas River. The absence of records north of the Kansas River may be a matter of inadequate sampling. It is common in smaller streams such as the Marais des Cygnes and Verdigris; it is rare in the Neosho River.

The westernmost records for *L. r. siliquoidea* in Kansas are: Kansas River, Manhattan, Riley County; Walnut River, Butler County (specimen not seen); Caney Creek, 1 mi. W Grenola, Elk County (sec. 7, T. 31 S, R. 8 E).

Description of Shell: Shell heavy, large, solid, subelliptical, subovate or ovate; somewhat compressed in young and in males, more

PLATE 42



Lampsilis radiata siliquoidea (Barnes), no. 10373, ♀; from Marais des Cygnes River, 1 mi. E and 9¾ mi. S Osage City, Osage Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 5⅝ inches.

swollen in old individuals and in females; anterior end rounded; posterior end obliquely truncated, meeting straight dorsal and ventral margins in bluntly rounded point; posterior ridge indistinctly rounded; beaks slightly elevated above hinge line, flattened, sculptured by 6-10 fine, wavy bars; epidermis yellowish-green to brownish, smooth and shining, usually having dark green rays of varying width; growth lines indistinct; female having strong post-basal enlargement, swollen in older specimens.

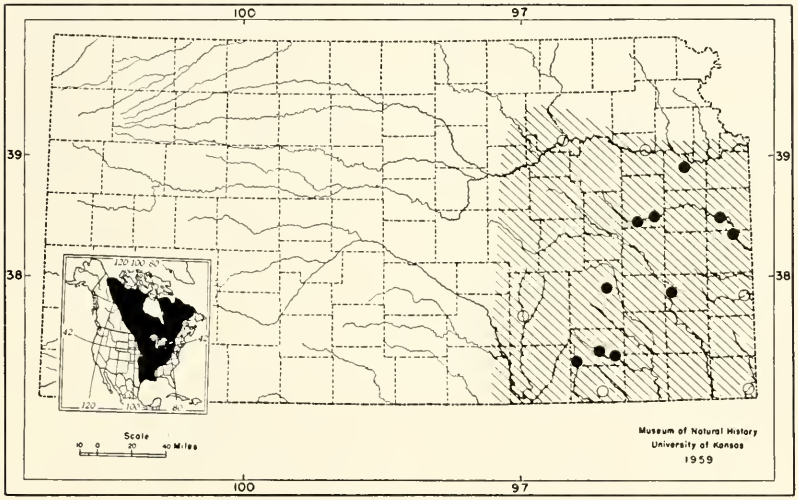


FIG. 38. Distribution of *Lampsilis radiata siliquoidea* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

Pseudocardinals variable, more or less triangular, erect, strong; laterally compressed, roughened, two in left valve, one large, sometimes one small anterior tooth in right valve; laterals long, straight or slightly curved, thin; no interdentum; beak cavities shallow, having dorsal muscle scars; anterior muscle scar excavated; posterior muscle scars not well marked; nacre silvery or milky-white, iridescent posteriorly (after Baker, 1928, p. 271).

Ecology: According to Baker (1928, p. 273) *L. r. siliquoidea* is typically found in quiet water in mud bottoms. In Kansas it occurs in most types of stream bottoms except shifting sand.

Host for Glochidia: Bluegill, *Lepomis macrochirus;* yellow perch, *Perca flavescens;* and walleye, *Stizostedion vitreum* are natural hosts for the glochidia.

Artificial infections have been successful on the gills of *Microp-*

terus dolomieui, M. salmoides, Pomoxis annularis, P. nigromaculatus, Stizostedion canadense (Baker, 1928, p. 273).

Remarks: In Kansas, *L. r. siliquoidea* is usually darker and less frequently rayed than typical specimens from the Mississippi River.

Because of its even thickness and fine quality of nacre, *L. r. siliquoidea* was highly valued for buttons. The epidermis of older specimens is usually greatly eroded. Large specimens from Kansas range from 5 to 5½ inches in length.

Plain Pocketbook Mussel

Lampsilis ovata ventricosa (Barnes)

Plate 43, figures 1-4; text figure 39

Unio ventricosus Barnes, 1823, Amer. Jour. Sci., 6:267, pl. 13, fig. 14 (outline); Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:51.

Lampsilis ovata ventricosa, Ortmann, 1919, Mem. Carnegie Mus., 8:301.

Lampsilis ventricosa, Scammon, 1906, Univ. Kansas Sci. Bull., 3:285; Simpson, 1914, A descriptive catalogue . . . mussels, p. 38; Leonard and Leonard, 1946, Univ. Kansas Sci. Bull., 31:117.

Unio occidens, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:120; Call, 1887, Bull. Washburn College Lab. Nat. Hist., 2:22.

Type Locality: Wisconsin and Mississippi rivers, Prairie du Chien, Wisconsin.

General Distribution: Mississippi River drainage from northern Arkansas and Tennessee north to Minnesota and Wisconsin, from New York west to eastern Kansas; St. Lawrence River drainages, and southern drainages of the Hudson Bay (La Rocque, 1953, p. 93).

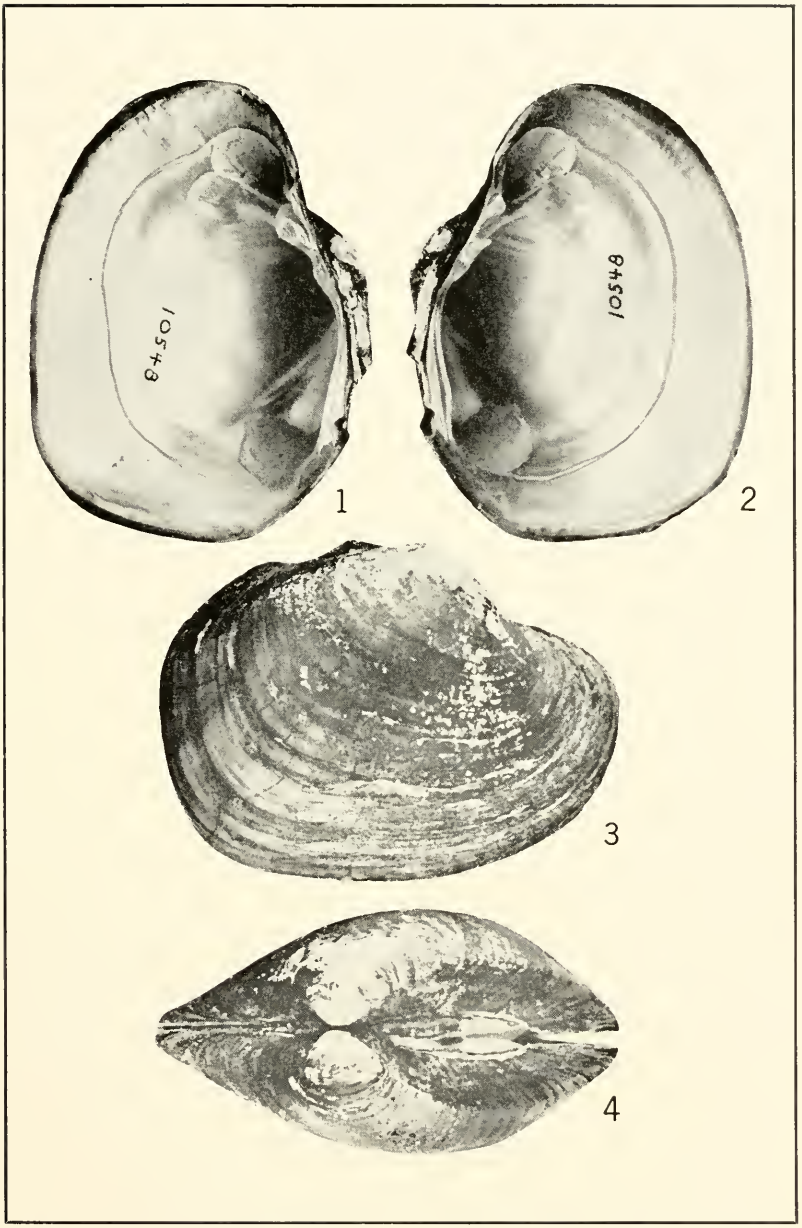
Occurrence in Kansas: Lampsilis ovata ventricosa is found in the rivers draining the southern portion of Kansas. It is common in the Neosho River but rare in all other rivers in Kansas.

The westernmost records for *L. o. ventricosa* in Kansas are: Kansas River, Topeka, Shawnee County (specimen not seen); Neosho River, 2 mi. W Americus, Lyon County; White Water River, Towanda, Butler County (specimen not seen); Elk River, 1½ mi. N Elk Falls, Elk County (sec. 34, T. 30 S, R. 11 E).

Description of Shell: Shell large, solid, obovate, inflated, having full, high beaks; beaks having few coarse, irregular corrugations; surface generally smooth, rest periods well marked; epidermis normally shining green, greenish-yellow or brownish having bright green rays; hinge line incurved in front of beaks, outcurved behind; ligament narrow, prominent under beaks, narrow in front of beaks; female having post-basal region greatly swollen.

Two, somewhat compressed pseudocardinals in left valve; two

PLATE 43



Lampsilis ovata ventricosa (Barnes), no. 10548, ♀; from Neosho River, ¼ mi. E Neosho Falls, Woodson Co., Kansas. Fig. 1, interior, right valve; fig. 2, interior, left valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 4⅛ inches.

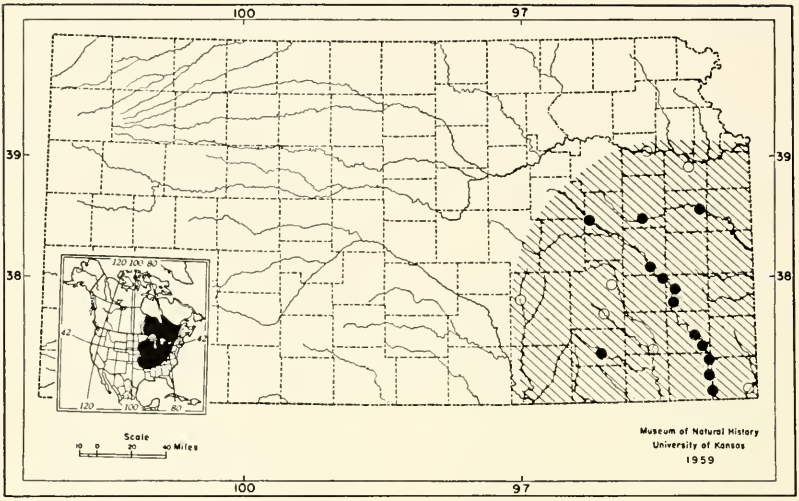


FIG. 39. Distribution of *Lampsilis ovata ventricosa* in Kansas. Insert map shows approximate distribution of this subspecies in North America.

compressed pseudocardinals in right valve; laterals short, slender, double in left valve, single in right valve; beak cavities deep, wide; muscle scars shallow, smooth, nacre brilliant, silvery, bluish-white, rarely pinkish (after Simpson, 1914, p. 38).

Ecology: *L. o. ventricosa* is typically found in small rivers in sand and gravel bottoms in water a few inches to 4 feet deep (Baker, 1928, p. 284). Kansas specimens more often occur in gravel than in sand bottoms.

Host for Glochidia: Glochidia of *L. o. ventricosa* have been observed on the gills of white crappie, *Pomoxis annularis* and sauger, *Stizostedion canadense* (Baker, 1928, p. 284).

Remarks: Scammon (1906, p. 286) reported the variety *L. ventricosa satura* Lea, in Kansas. The variety *satura* is "greatly inflated, with livid or smoky-colored, sometimes blackish epidermis, and the marsupial swelling is remarkably developed" (Simpson, 1914, p. 41). Scammon may have had examples of *satura*; however because he does not illustrate a specimen and because there are no specimens in his Kansas collection that are *satura,* we are not sure he had this variety from Kansas. The epidermis of a typical *L. o. ventricosa* is shiny, light to dark green, or greenish-yellow. There are usually bright green rays on the shell, but these fade in some older specimens.

Because typical *L. o. ventricosa* are known from Missouri (Utterback, 1916a, p. 186) and because Kansas examples more closely resemble *ventricosa* than *satura*, we have referred Kansas specimens to *L. o. ventricosa*. A more thorough understanding of the trans-Mississippian forms of this species is necessary before the intergradation is adequately understood.

Inasmuch as there are intergrades between *ventricosa* and *ovata* (Ortmann, 1919, p. 301), it is not proper to elevate *ventricosa* to the species level as some recent authors have done.

The value of the pocketbook mussel was considered low due to the frequent chalky consistency of the shell. The nacre is a beautiful white and rarely blemished. The drying qualities of the shell are good. Large specimens from Kansas range from 5½ to 6 inches in length.

Genus Dysnomia Agassiz 1852

Shell rounded, oval or subtriangular, solid, inflated, generally smooth, rayed; beak sculpture delicate, often obsolete, double-looped; female differs from male in having decided inflation of shell in post-basal region (after Baker, 1928, p. 295). Type: *Unio foliatus* Hildreth.

Snuffbox Mussel

Dysnomia triquetra (Rafinesque)

Plate 44, figures 1-4; text figure 40

Truncilla triqueter Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:300, pl. 81, figs. 1-4.

Dysnomia triquetra, Ortmann and Walker, 1922, Occas. Papers Mus. Zool. Univ. Michigan, no. 112, p. 65.

Truncilla triquetra, Scammon, 1906, Univ. Kansas Sci. Bull., 3:283; Simpson, 1914, A descriptive catalogue . . . mussels, p. 5.

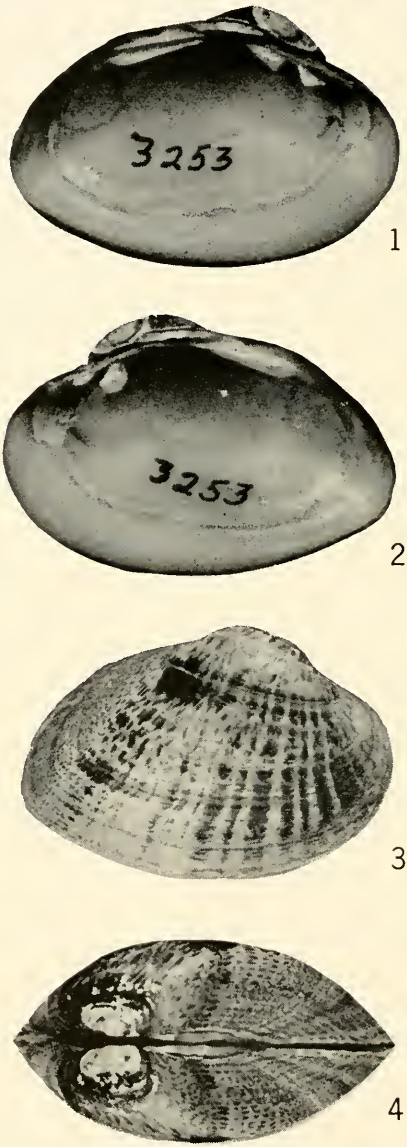
Type Locality: Falls of the Ohio.

General Distribution: Mississippi River drainage from western New York west to Nebraska and eastern Kansas, north to Minnesota, and south to West Virginia, Tennessee, and northern Alabama (Baker, 1928, p. 298).

Occurrence in Kansas: Scammon (1906, p. 284) reported *Dysnomia triquetra* from one locality in the Marais des Cygnes River, Ottawa, Franklin County, Kansas. This specimen is no longer available; however, there is one specimen obtained by Scammon on March 20, 1909, from the Wakarusa River.

Description of Shell: Shell small, valves thickened, subovate, depressed, triangular or somewhat trapezoidal; anterior end rounded;

PLATE 44



Dysnomia triquetra (Rafinesque), no. 3253; from Wakarusa River, near Lawrence, Douglas Co., Kansas. Fig. 1, interior, left valve; fig. 2, interior, right valve; fig. 3, exterior, right valve; fig. 4, dorsal aspect of shell. Actual length, 2 inches.

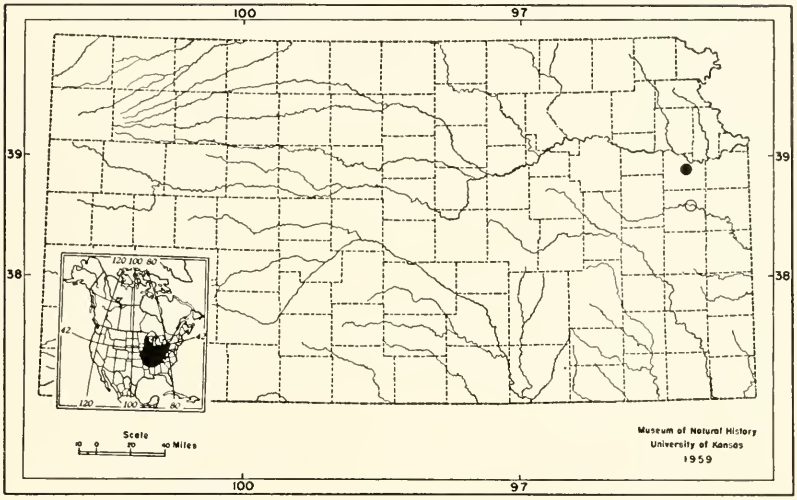


FIG. 40. Distribution of *Dysnomia triquetra* in Kansas. Insert map shows approximate distribution of this species in North America.

posterior end truncated; ventral margin straight or slightly curved, slightly emarginate posteriorly; dorsal margin short, slightly curved in young specimens, forming an angle with the sharply truncated posterior margin, in older specimens angle bluntly rounded; posterior ridge sharply defined; beaks swollen, somewhat elevated above hinge line; beak sculpture consisting of 3-4 faint, more or less double-looped bars; valves swollen but flattened on sides; epidermis yellowish or yellowish-green having many dark green rays covering all but flattened posterior slope behind posterior ridge; rays usually broken into squarish, triangular, or chevron-shaped spots of color; post-basal region somewhat swollen in females.

Two strong, high, longer than wide, very ragged pseudocardinals in each valve, upper denticle of right valve smaller; laterals short, strong, serrated, elevated, roughened; no interdentum; cavity of beaks rather deep; adductor scars distinct; dorsal muscle scars in beak cavity; nacre silvery-white (after Baker, 1928, p. 296).

Ecology: Baker (1928, p. 298) gives the habitat as gravel, stony, and sandy bottoms in shallow water having swift currents. Scammon (1906, p. 284) recovered a specimen from a hard mud and rocky bottom in shallow water. The current was not swift. The habitat of the specimen from the Wakarusa River is not known; however, this is typically a stream having a soft mud bottom.

Host for Glochidia: Not recorded.

Remarks: Because only two specimens of *D. triquetra* are known from Kansas, and because it has not been recovered from Kansas since 1909, it might well be absent from the state today.

In Kansas, *D. triquetra* can be confused only with the closely related *Truncilla truncata. T. truncata* is more nearly triangular having a sharper posterior ridge, and the posterior part of the shell is excavated. The epidermis of *D. triquetra* is more highly polished and more heavily marked with rays.

The only Kansas specimen available measures approximately 2 inches in length.

SPECIES IN KANSAS THAT MAY HAVE BEEN EXTIRPATED SINCE 1890

On the bases of descriptions and illustrations by Scammon (1906), we think that *Anodonta suborbiculata, Obovaria olivaria*, and *Ptychobranchus fasciolare* were validly reported for Kansas. For reasons unknown to us, the three species now seem to be absent from the unionid fauna of the state. So far as we know, no specimens of these three species are preserved from Kansas. If the three species should occur in Kansas, we hope that the following accounts taken in part from Scammon (1906) will aid in their identification.

Subfamily Anodontinae

Genus Anodonta Lamarck, 1799

Heel-Splitter Mussel

Anodonta suborbiculata Say

Plate 45, figure 3

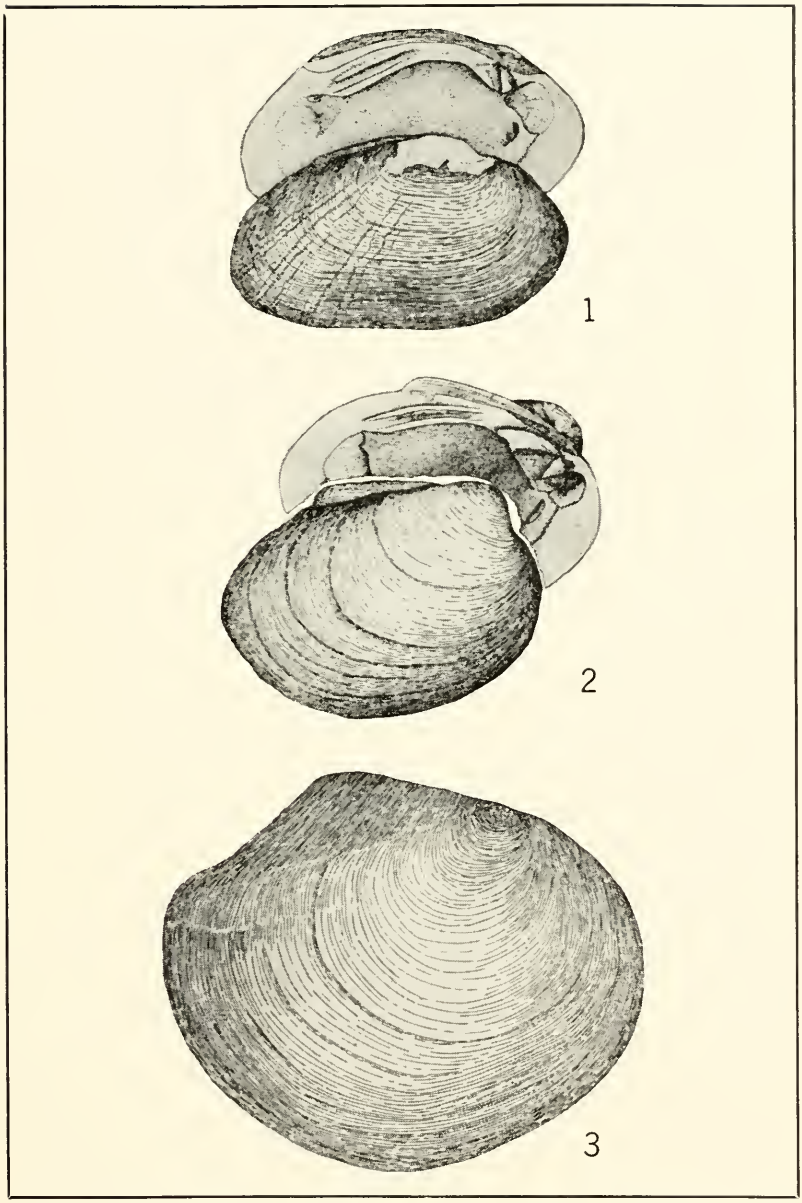
Anodonta suborbiculata Say, 1831, New Harmony Disseminator (newspaper form, no pagination); Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:96; Call, 1885, *op. cit.*, p. 123; Scammon, 1906, Univ. Kansas Sci. Bull., 3:325; Simpson, 1914, A descriptive catalogue . . . mussels, p. 400.

Type Locality: Ponds near the Wabash River.

General Distribution: Southern portion of Mississippi River system, Nebraska, Iowa, Illinois to Louisiana (Simpson, 1914, p. 400).

Description of Shell: "Shell very large, thin, slightly compressed, suborbiculate in outline. Anterior margin flatly curved; ventral margin almost circular; posterior margin rounded for the first fifth ventrally, and very slightly incurved for the remaining four-fifths;

PLATE 45



Three unionid mussels probably extirpated in Kansas. The dates when last obtained in Kansas are unknown. Fig. 1, *Ptychobranchus fasciolare* (Rafinesque); fig. 2, *Obovaria olivaria* (Rafinesque); fig. 3, right valve of *Anodonta suborbiculata* Say. (Figs. 1, 2, and 3 from Scammon, 1906.) Approximately ½ natural size.

dorsal margin straight or very slightly curved. Umboidal ratio variable, from 0.25 to 0.40. Umbones very low and flat, and ornamented with four or five pairs of slight nodules arranged in a series which represent degenerate double-looped ridges. Anterior and lateral umboidal slopes flatly curved; posterior umboidal ridge low but distinct; posterior slope slightly excavated. Epidermis straw-yellow to dark brown in color, smooth and shining except for the posterior umboidal slope, which is slightly roughened; fine green rays are sometimes present. Lines of growth fine and continuous. Ligament dark and rather stout.

"Interior: Hinge line very thin. Muscle scars large, very faint. Pallial line very faint. Cavity of shell rather large, of beaks very slight. Nacre white, varying to a light salmon, deepest in color near the umbones, very iridescent" (Scammon, 1906, p. 325).

Ecology: Scammon (1906) reported the habitat of *Anodonta suborbiculata* in Kansas to be quiet water and muddy or somewhat sandy banks. This habitat is reproduced many times in eastern Kansas; however, intensive collecting in areas reported by Call (1885-1886) and Scammon (1906) have yielded no specimens of *A. suborbiculata.* As best as can be determined from the literature *A. suborbiculata* occurred in the eastern one-fourth of the state.

Host for Glochidia: Not recorded.

Remarks: Specimens of *A. suborbiculata* were obtained by one of us (Leonard) in 1949, but subsequently lost, from a pond east of the Neosho River, 4.5 mi. S Humboldt and 1.5 mi. W highways U. S. 169-59, Allen County, Kansas. These specimens were never catalogued. Murray carefully sampled the area in 1958 and 1959, but was unable to recover examples of *A. suborbiculata.* Leonard examined the exact location in 1959, and he was unable to recover examples; therefore, this species has probably been extirpated from Kansas.

Subfamily Lampsilinae

Genus **Obovaria** Rafinesque, 1819

Hickory-Nut Mussel

Obovaria olivaria (Rafinesque)

Plate 45, figure 2

Amblema olivaria Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:314.
Obovaria olivaria, Ortmann and Walker, 1922, Occas. Papers Mus. Zool., Univ. Michigan, no. 112, p. 46.
Unio ellipsis, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50.
Unio pealei, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:50; Call, 1885, *op. cit.,* p. 96; Call, 1886, *op. cit.,* p. 181.
Obovaria ellipsis, Scammon, 1906, Univ. Kansas Sci. Bull., 3:305; Simpson, 1914, A descriptive catalogue . . . mussels, p. 299.

Type Locality: Ohio.

General Distribution: "Upper Mississippi system as far south as the Tennessee and Arkansas River; St. Lawrence drainage area" (Simpson, 1914, p. 299).

Description of Shell: Shell of moderate size, short, oval, quite heavy, especially anteriorly, somewhat inflated. Anterior margin rounded; ventral margin decidedly bowed; posterior margin rounded or roundly pointed dorsally; dorsal margin rather curved, and meeting the posterior at an angle of 130 to 160 degrees. Umboidal ratio generally small but highly variable; umbones full and swollen, decurved and ornamented with approximately seven slightly double-looped ridges. Anterior umboidal slope abruptly rounded; posterior slope gradually rounded but flattened somewhat near the posterior margin in the female. Epidermis smooth, often clothlike, with occasional dark continuous lines of growth, in color from dark horn to honey-brown; young specimens a sage-green and marked with numerous narrow rays of dull green, which are obscurely present in shells of many adults. Ligament rather long, stout, chestnut brown.

Interior: Pseudocardinals heavy, variable, generally high, erect, columnar or pyramidal, posterior left one often long and lamellar, double in left and single in right valve. Laterals of varying length and curvature, coarse and high. Anterior adductor cicatrix of moderate size, deeply excavated, set in front of pseudocardinals. Posterior scars of moderate size, well impressed, often confluent. Pallial line generally impressed its entire length. Dorsal cicatrices numerous round pits in cavity of umbones. Cavity of beaks and shell

moderate. Nacre white, slightly iridescent posteriorly (After Scammon, 1906, pp. 305-306).

Ecology: "It is a lover of water of moderate depth and of sandy riverbeds" (Scammon, 1906, p. 306). Although the above habitat for *Obovaria olivaria* is repeated many times in eastern Kansas, the species has not been recovered since approximately 1905.

Host for Glochidia: The glochidia naturally occur on the gills of sturgeon, *Scaphirhynchus platorhynchus* (Coker, *et al.*, 1921).

Remarks: Inasmuch as *O. olivaria* once occurred in large numbers in eastern Kansas and inasmuch as no examples have been recovered since approximately 1905, the species is assumed to be extirpated in Kansas.

Subfamily Lampsilinae

Genus Ptychobranchus Simpson 1900

Kidney-Shell Mussel

Ptychobranchus fasciolare (Rafinesque)

Plate 45, figure 1

Obliquaria (*Ellipsaria*) *fasciolaris* Rafinesque, 1820, Ann. Gen. Sci. Phys., Bruxelles, 5:303.

Ptychobranchus fasciolare, Ortmann and Walker, 1922, Occas. Papers Mus. Zool., Univ. Michigan, no. 112, p. 42.

Unio phaseolus, Call, 1885, Bull. Washburn College Lab. Nat. Hist., 1:94; Call, 1885, *op. cit.*, p. 121; Call, 1886, *op. cit.*, p. 182.

Ptychobranchus phaseolus, Scammon, 1906, Univ. Kansas Sci. Bull., 3:319; Simpson, 1914, A descriptive catalogue . . . mussels, p. 333.

Type Locality: Muskingum River, Ohio.

General Distribution: Ohio, Tennessee, and Cumberland river systems; Lower Peninsula of Michigan; Kansas; Arkansas; Oklahoma; Louisiana (Simpson, 1914, p. 334).

Description of Shell: "Shell of moderate to large size, compressed, elongate ellipsoid in the outline, very heavy. Anterior margin very decidedly rounded; ventral margin gently bowed or straight; posterior margin roundly pointed, the point being directed ventrally; dorsal margin oblique and curved, generally passing gradually into the posterior margin. Umboidal ratio, about 0.23. Umbones low and compressed, marked with a number of very fine undulating ridges. Umboidal slopes flattened dorsally but decidedly curved marginally. Posterior umboidal ridge prominent but rounded. Epidermis light horn color (often with an olive-green cast) to dark chestnut-brown. Rays either fine, dark, and wavy, or broad and

interrupted. Lines of growth numerous, coarse, and often imbricated. Lunule large and elongate. Ligament short and stout.

"Interior: Pseudocardinals small, low serrate, bluntly pyramidal, single in the right and double in the left valve. Laterals short, heavy, slightly curved, oblique. Interdentum quite long, smooth, broad. Anterior adductor cicatrix deeply pitted, elongate, placed in front of the pseudocardinals. Posterior scars deeply impressed and distinct, the retractor almost hidden, and placed in on the tip of the lateral tooth; adductor scar elongate and pointed posteriorly. Dorsal muscle scar large and well impressed on the lower surface of the interdentum. Pallial line impressed its entire length. Branchial area well impressed, cavity of shell small. Beaks practically without a cavity. Nacre milk-white, slightly iridescent posteriorly" (Scammon, 1906, pp. 319-320).

Remarks: Simpson (1914) expressed the opinion that *P. fasciolare* recorded from the areas of the southwest (Kansas included) was probably *P. clintonense* Simpson; conversely, Scammon (1906) expressed the opinion that *P. clintonense* identified from Kansas was probably *P. fasciolare.* Inasmuch as no specimens of either species are available and inasmuch as the illustration of *P. fasciolare* by Scammon (1906) is insufficient to distinguish what Scammon had, we cannot determine whether or not Simpson was correct. We have listed *P. fasciolare* instead of *P. clintonense* for Kansas because we share Scammon's opinion concerning *P. clintonense* when he states "This species [*P. clintonense*] is described by Simpson from the Little Red river near Clinton, Ark. I [Scammon] have a number of specimens from Spring river at Baxter Springs which will probably fall under this species, but until there is more material in better condition at hand for identification I [Scammon] list this species for the state as doubtful. It is quite close to the preceding one." (Scammon, 1906, p. 321.) Agricultural practices, as well as lead and zinc mining, in the areas surrounding the Spring River in Kansas have polluted and increased the turbidity of this river. If examples of *P. fasciolare* or *P. clintonense* have been collected in Kansas since 1890, they are unknown to us. Inasmuch as specimens are unknown since 1890 and inasmuch as clear water streams do not exist in Kansas in 1961, it seems likely that *P. fasciolare* has been extirpated in Kansas.

TABLE 1.—List of Species Reported by Call and Scammon, Invalidly Recorded for Kansas.

Currently Recognized Name	Names Used by Call and Scammon	
	Call (1885-1887)	Scammon (1906)
1. *Actinonaias carinata gibba* (Barnes)		1. *Lampsilis ligamentina gibba* Simpson
2. *Lampsilis ovata satura* Lea		2. *Lampsilis ventricosa satura* Lea
3. *Leptodea leptodon* (Rafinesque)	1. *Unio tenussimus* Lea	3. *Lampsilis leptodon* (Rafinesque)
4. *Plethobasus cicatricosum* (Say)		4. *Pleuroboma cicatricosum* (Say)
5. *Pleurobema cordatum plenum* (Lea)	2. *Unio plenus* Lea	5. *Quadrula plena* (Lea)
6. *Quadrula aspera* (Lea)		6. *Quadrula aspera* (Lea)
7. *Quadrula fragosus* (Conrad)	3. *Unio fragosus* Conrad	7. *Quadrula fragosa* (Conrad)
8. *Quadrula houstonensis* (Lea)	4. *Unio houstonensis* Lea	8. *Quadrula houstonensis* (Lea)
9. *Quadrula petrinus* (Gould)	5. *Unio petrinus* Gould	
10. *Quadrula speciosa* (Lea)		9. *Quadrula speciosa* (Lea)
11. *Quadrula sphaericus* (Lea)	6. *Unio sphaericus* Lea	
12. *Uniomerus tetralasmus camptodon* Say		10. *Unio tetralasmus camptodon* Say

TABLE 2.—Species Reported by Call and Scammon, of Doubtful Occurence in Kansas.

Current Name	Names Used by Call and Scammon	
	Call (1885-1887)	Scammon (1906)
1. *Actinonaias ellipsiformis* (Conrad)	1. *Unio spatulatus* Lea	1. *Lampsilis ellipsiformis* (Conrad)
2. *Anodonta dejecta* Lewis	2. *Anodonta dejecta* Lewis	
3. *Anodontoides ferussacianus* (Lea)	3. *Anodonta ferussaciana* Lea	2. *Anodonta ferussaciana* Lea
4. *Fusconaia ebenus* (Lea)	4. *Unio ebenus* Lea	3. *Quadrula ebenus* (Lea)
5. *Fusconaia rubida* (Lea)	5. *Unio negatus* Lea	
6. *Fusconaia undata* (Barnes)	6. *Unio trigonus* Lea	4. *Quadrula trigona* (Barnes)
7. *Lampsilis higginsii* (Lea)		5. *Lampsilis higginsii* (Lea)
8. *Lampsilis powellii* (Lea)	7. *Unio powellii* Lea	6. *Lampsilis powellii* (Lea)
9. *Ptychobranchus clintonense* Simpson		7. *Ptychobranchus clintonense* Simpson

TABLE 3.—Species Validly Recorded by Call and Scammon, But Now Absent From Kansas.

Currently Recognized Name	Names Used by Call and Scammon	
	Call (1885-1887)	Scammon (1906)
1. *Anodonta suborbiculata* Say	1. *Anodonta suborbiculata* Say	1. *Anodonta suborbiculata* Say
2. *Obovaria olivaria* (Rafinesque)	2. *Unio ellipsis* Lea	2. *Obovaria ellipsis* (Lea)
	Unio pealei Lea	
3. *Ptychobranchus fasciolare* (Rafinesque)	3. *Unio phaseolus* Hildreth	3. *Ptychobranchus phaseolus* (Hildreth)

ALLOCATION OF SPECIES PREVIOUSLY REPORTED FROM KANSAS

Call (1885-1887) and Scammon (1906) reported 12 species that are judged to be invalid records for Kansas (Table 1). Recognizing that the streams of the southern drainages pass through states having a typical southern fauna, early authors tended to identify variants in Kansas species as members of the southern fauna. As an example, both Call and Scamman recorded *Quadrula houstonensis* typically found in Texas. We judge that this record was based upon a non-pustulose *Quadrula pustulosa*. It is possible that some of the species listed on Table 1 did at one time occur in Kansas, but on the basis of our present knowledge of the Kansas unionid fauna, the available specimens in Scammon's collections, and the illustrations as given by Scammon, it seems unlikely.

In Table 2 are listed nine species of doubtful occurrence in Kansas. Because Call and Scammon gave few or no descriptions and no illustrations of these species, it is not possible to determine the validity of their records. *Anodonta danielsii* has the type locality of Topeka, Kansas; but because recent collections in that area indicated that only *A. grandis* occurs and because illustrations and descriptions of *A. danielsii* are judged to be of *A. grandis*, we have placed *A. danielsii* in synonymy with *A. grandis*.

Three species are thought to have been extirpated in Kansas. They are listed in Table 3 and were discussed on pages 158-163.

Table 4 summarizes the allocation of species reported by Call and Scammon, as well as those covered by this report.

TABLE 4. Number of Genera and Species Recorded by Call (1885-1887), by Scammon (1906), and in This Report.

	Call (1885–1887)	Scammon (1906)	This report (1961)
Total number of genera recorded	3	14	24
Total number of species recorded and presently recognized in Kansas	36	39	41
Species validly recorded but now presumably absent from Kansas	3	3	3
Number of species invalidly recorded	6	10	00
Number of named kinds now in synonymy	12	4	00
Number of species of doubtful occurrence	7	7	00
Total number of species recorded	64	63	44

PHYSIOGRAPHY OF KANSAS DRAINAGE SYSTEMS

Systems Ancestral to Present Drainage

Ancestral drainage systems cannot be deciphered in Kansas previous to the beginning of the Pliocene, inasmuch as no record of earlier Tertiary phenomena has been preserved in the western two-thirds of the state, and none but extremely fragmentary evidence exists east of the Flint Hills. West of the Flint Hills, Pliocene sediments were deposited on a mature topography underlain by Cretaceous rocks, in which relatively shallow valleys extended generally eastward or southeastward. East of the Flint Hills, high level chert gravels in a matrix of red clays, undoubtedly derived from prolonged weathering, lie above levels that can be fixed as Pleistocene in age. From the existing fragmentary evidence, it seems that drainage east of the Flint Hills extended in a generally eastward or southeastward direction. Throughout Pliocene time and through early Pleistocene time, the Flint Hills continued to act as a drainage divide, there being no communication across them (Frye and Leonard, 1959).

The Flint Hills were breached in late Kansan time, and the Smoky Hill-Republican systems were captured by an ancestral Kansas River at or about the time the Kansan ice stood at the latitude of Riley County.

If these drainage changes, occurring as they did in the relatively

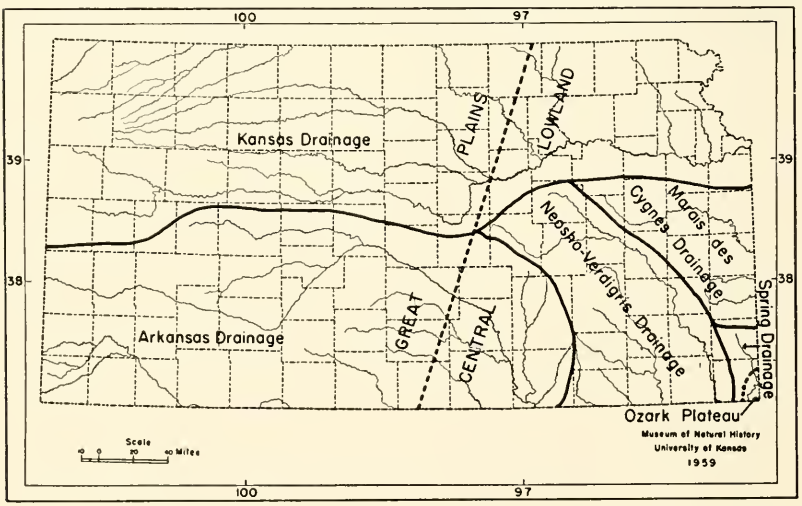


FIG. 41. Map of the State of Kansas showing major river drainages and major physiographic divisions.

recent geologic past, had any profound effect upon the unionid fauna, evidence is lacking to demonstrate the effects. All streams west of the Flint Hills left the present boundaries of the state flowing in a southeasterly or southerly direction prior to Late Kansan time, but lack of information from Oklahoma and other areas to the south makes it impossible to learn whether or not any of these streams flowed directly into the Gulf of Mexico (Frye and Leonard, 1952). Evidence on this point is further weakened by the absence of a satisfactory fossil record of unionids in Pliocene and early Pleistocene sediments. In summary, useful knowledge of ancestral drainages in Kansas insofar as they bear upon the unionid fauna, extends no farther into the past than late Kansan time, when, in general, the present-day drainage pattern became established.

Present Drainage Systems (Fig. 41)

The state of Kansas is typically a plains state that gently slopes from the western border (approximately 4,000 feet) to the eastern border (approximately 700 feet). The state is drained by four major river systems: Kansas-Smoky Hill-Republican, Marais des Cygnes, Neosho and Verdigris, and Arkansas river systems. Each of these systems varies in length and drains several types of soil over its length.

Physiographically, Kansas may be divided into two major areas (Schoewe, 1949); the Great Plains and the Central Lowlands. The Marais des Cygnes as well as the Neosho and Verdigris systems are situated within the Central Lowlands. The Marais des Cygnes system drains the middle eastern portions of the state and has a rocky, mud bottom. This system empties into the lower Missouri River. The Neosho and Verdigris systems are here considered as one system because they join the Arkansas River immediately across the Kansas-Oklahoma border and because the mussel fauna of the two systems is essentially the same. The Neosho and Verdigris systems and their tributaries drain the southeastern portions of the state. The stream bottom of the lower portions of the systems is composed of mud and rock mixed with gravel. The source of the Verdigris does not drain areas having sandy soil; therefore the bottom is rarely sandy, but composed of silt and rock. The stream bottom of the upper Neosho is frequently sandy, but never shifting sand. The Neosho and Verdigris systems empty into the Arkansas River which eventually joins the lower part of the Mississippi River.

The Arkansas River system drains the southern portion of the Great Plains and the extreme western portion of the Central Low-

lands. Because the majority of this system crosses the sandy soils of western Kansas, the stream bottom is primarily of shifting sand. The south-central portion does have some silt coming from the western edge of the Central Lowlands and is, therefore, suitable for some unionids.

The Kansas system, the largest and longest system in Kansas, drains the entire northern ¼ to ½ of the state and flows, in an easterly direction to the Missouri River, over the Great Plains in western Kansas and the Central Lowlands in the eastern ¼ of Kansas. West of the Central Lowlands, the Kansas system has typically a shifting sand bottom; however within the Central Lowlands drainage, which also includes the Drift Plains of the Kansan ice advances, the stream bottoms become silty and do support several species of unionids.

A small, poorly studied, but possibly highly significant drainage system is the Spring River. This will be given little attention because the river traverses only the extreme southeastern portion of the extreme southeastern county of Kansas, Cherokee County, and because the fauna has been poorly sampled. Inasmuch as the stream originates as a clear water spring in southwestern Missouri and empties into the Neosho River in eastern Oklahoma, it might be expected to have an unusual fauna; however the scanty records from this system indicate that the fauna is essentially like that of the lower Neosho and Verdigris systems.

In summary, that portion of the state lying west of the Central Lowlands is not suitable for most fresh-water mussels because of the shifting sand bottoms; nevertheless, populations of mussels do occur in isolated habitats. The Central Lowland drainages support large populations and at least 41 kinds of fresh-water mussels.

ORIGIN OF KANSAS UNIONID FAUNA

Bryant Walker (1917) proposed that the North American unionid fauna east of the Rocky Mountains originated in Cretaceous times in the swamps, streams, and bayous along the eastern shores of North America. Subsequent changes in the elevation of the continent, and the various Pleistocene ice ages resulted in the periodic isolation of this fauna at different times and in different areas of the continent. These changes resulted in three major areas and three distinct faunal assemblages: 1) the fauna and area east of the Appalachian Mountains; 2) the fauna and area of the Mississippi Valley; 3) the fauna of the Alabama River and its tributaries. A fourth area and fauna occurs west of the Rocky Mountains and probably resulted from migration of prototypes from Siberia.

UNIONID SPECIES AND SUBSPECIES IN KANSAS — MAJOR RIVER SYSTEMS IN KANSAS AND THE UNITED STATES	Kansas	Marais des Cygnes	Neosho And Verdigris	Arkansas	Restricted To Mississippi Drainage	Restricted To South Of Missouri River
Actinonaias carinata carinata			●			
Anodonta grandis	●	●	●	●		
Anodonta imbecilis		●	●	●	●	
Arcidens confragosus		●			●	
Carunculina parva	●	●	●	●		
Crenodonta peruviana costata	●	●	●	●		
Crenodonta peruviana peruviana	●	●	●	●		
Cyprogenia aberti			●		●	●
Dysnomia triquetra	●	●			●	
Elliptio dilatatus		●	●			
Fusconaia flava	●	●	●			
Lampsilis anodontoides anodontoides	●	●	●	●		
Lampsilis anodontoides fallaciosa	●	●	●		●	
Lampsilis radiata siliquoidea	●	●	●	●		
Lampsilis ovata ventricosa	●	●	●	●		
Lasmigona complanata	●	●	●	●		
Lasmigona costata			●			
Leptodea fragilis	●	●	●	●		
Leptodea laevissima	●	●	●	●	●	
Ligumia recta latissima		●	●			
Ligumia subrostrata	●	●	●	●	●	
Megalonaias gigantea		●	●			
Obliquaria reflexa		●	●	●		
Plagiola lineolata			●		●	
Plethobasus cyphyus			●		●	
Pleurobema cordatum catillus			●		●	
Pleurobema cordatum coccineum		●	●			
Pleurobema cordatum pyramidatum			●		●	
Proptera alata	●	●	●			
Proptera capax			●		●	
Proptera purpurata			●	●	●	●
Quadrula cylindrica			●		●	
Quadrula metanevra			●		●	
Quadrula nodulata			●		●	
Quadrula pustulosa	●	●	●	●	●	
Quadrula quadrula	●	●	●	●		
Strophitus rugosus	●	●	●	●		
Tritogonia verrucosa	●	●	●	●		
Truncilla donaciformis	●	●	●		●	
Truncilla truncata	●	●	●	●	●	
Uniomerus tetralasmus	●	●	●	●		
Total Number 41	22	29	39	20	19	2

TABLE 5.—Occurrence of Mussels in the Four Major River Systems in Kansas, Indicating Mussels Restricted to the Mississippi Drainage and Mussels Occurring in That Drainage South of the Missouri River.

Baker (1928) proposed that the North American unionid fauna originated in Texas during the Triassic period. If these early forms used fishes as hosts for the glochidia, migration to other areas of North America (particularly the eastern and northeastern portions) quickly ensued. The Mississippi embayment caused many groups of unionids to be isolated on either side of this inland sea. Changes in the earth's crust ultimately resulted in three areas of unionid development and distribution; these centers agree with those proposed by Walker (see above), and are those areas recognized today as having distinctive faunal assemblages.

On the basis of the relationships of the Kansas fauna to that of the Mississippi River (Table 5) and the known Pleistocene drainages, the Kansas unionid fauna is judged to have originated from the Mississippi Valley.

Inasmuch as only two of the 41 species (Table 5) recognized in Kansas are restricted to drainages south of the Missouri River, and because all of the 41 species occur within the Mississippi River system, we judge that the present day fauna of unionids in Kansas is derived from the Mississippi Valley fauna and is composed of species having ubiquitous distribution in the valley. Although it is expected that some species restricted to southern areas should exist in Kansas, it is surprising that more southern species do not occur in the state; therefore it is assumed that the presence of but two southern species in Kansas reflects the peripheral position of the state with relation to the southern fauna.

GENERALIZATIONS AND CONCLUSIONS

1) Twenty-four genera and 41 species and subspecies of mussels occur in Kansas streams.
2) All 41 species occur in the eastern ¼ of Kansas, but probably no more than eight occur west of the division between the Central Lowlands and Great Plains. These eight are as follows: *Anodonta grandis, A. imbecilis, Carunculina parva, Lampsilis anodontoides anodontoides, Lasmigona complanata, Leptodea laevissima, Tritogonia verrucosa, Uniomerus tetralasmus.*
3) The kinds and numbers of mussels decrease from the southeastern to the northwestern and southwestern parts of the state, and few or no mussels occur in the extreme western corners of the state.
4) The Neosho River has the greatest number and most kinds of mussels.

5) The kinds and numbers of mussels present are greatly affected by the types of stream bottoms; the shifting sand bottoms of western Kansas exclude all species of mussels in Kansas.
6) The unionid fauna of Kansas is composed of species found primarily throughout the Mississippi Valley; only *Cyprogenia aberti* and *Proptera purpurata* are species of typically southern faunal assemblages.
7) The Kansas fauna of mussels is derived from the Mississippi Valley assemblage and is at the periphery of the western range; in addition, Kansas is at the periphery of the range of the southern fauna. The geographical location of Kansas is unique in relation to mussel distribution, and additional studies are necessary to clarify the numerous specific and subspecific relationships to the main fauna of the Mississippi Valley.
8) The decrease in abundance of several species and the extirpation of three species from Kansas since the studies by Call and Scammon indicate the necessity for immediate controls on industrial pollution and increasing siltation of Kansas streams.
9) Fresh-water mussels are an important source of food for many mammals and fishes, and are a valuable latent resource of the state of Kansas.

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GLOSSARY

ACCESSORY DENTICLE.—Small nacreous swelling on the hinge line of the bivalve shell, anterior or posterior to the main pseudocardinal teeth.

ACCESSORY LATERAL TOOTH.—Small nacreous, lamellar swelling on the hinge line of the bivalve shell, ventral to the main lateral teeth.

ADDUCTOR MUSCLE.—Muscle that closes the two valves of the shell; the muscle fibers extend from one valve to the opposing valve.

ALATE.—Said of shells that have an anterior or posterior winglike projection of the two valves of the shell, extending dorsally above the hinge line.

ANGULATE.—Said of shells having either the anterior or posterior margins forming a relatively acute angle.

ANTERIOR ADDUCTOR MUSCLE.—The largest of the anterior muscles. See ADDUCTOR MUSCLE.

ANTERIOR ADDUCTOR MUSCLE SCAR.—The largest of the nacreous impressions at the anterior end of the shell, forming the attachment of the anterior adductor muscle (Plate 2, fig. 5).

ANTERIOR PROTRACTOR MUSCLE.—Muscle situated at the anterior end of the animal and aiding in extending the foot; the fibers extend from the visceral mass to the anterior part of the shell (Plate 3, fig. 3).

ANTERIOR PROTRACTOR MUSCLE SCAR.—A relatively small, nacreous impression in the valve forming the attachment of the anterior protractor muscle (Plate 2, fig. 5).

ANTERIOR RETRACTOR MUSCLE.—Muscle situated near the anterior end of the animal, and aiding in retraction of the foot. The fibers extend from the visceral mass to the shell (Plate 3, fig. 3).

ANTERIOR RETRACTOR MUSCLE SCAR.—A relatively small, nacreous impression in the valve forming the attachment of the anterior retractor muscle (Plate 2, fig. 5).

ANTERIOR SLOPE.—The area across the dorsal portion of the valve extending from the umbo to the anterior margin (Plate 2, figs. 2 and 3).

ANTERIOR WING.—A dorsal projection of the shell anterior to the umbo (Plate 33).

ARAGONITE.—A crystalline form of calcium carbonate that is one of two main components of the unionid shell (see calcite).

ARCUATE.—Said of shells having the anterior or posterior margins curved in the form of a bow.

BEAK.—See UMBO.

BEAK SCULPTURE.—A pattern of ridges or pustules on the dorsalmost portion of the umbo.

BRANCHIAL OPENING.—The modified posterior portion of the mantle that forms the incurrent and excurrent siphons through which water and suspended materials enter or leave the animal.

CALCITE.—A crystalline form of calcium carbonate that is one of two main components of the unionid shell. It differs in molecular structure from aragonite.

CARDINAL TOOTH.—An elevation on the hinge plate of one valve that interlocks with a corresponding depression on the opposing valve: situated directly ventral to the umbo. Not found in unionids (see PSEUDOCARDINAL TOOTH).

CELT-SHAPED.—Said of some unionid glochidia in which the shape resembles an ax or chisel.

CHEVRONS.—V-shaped marks or structures on the exterior of unionid shells.

CICATRICE.—Scar or impression in the nacre of the unionid valve formed by the attachment of a muscle to the valve.

CRENULATE.—Said of shells having a roughened or scalloped border.

CRETACEOUS.—A geologic era starting approximately 125 million years ago and lasting approximately 55 million years.

CRYSTALLINE STYLE.—A secreted, rodlike structure situated in a diverticulum of the stomach of some pelecypods; mediates the digestion of carbohydrates.

CTENIDIUM.—A comblike respiratory organ or gill.

CUSP.—See PSEUDOCARDINAL TOOTH.

DIOECIOUS.—Said of animals in which the male reproductive organs are in one individual and the female reproductive organs are in another.

DORSAL HINGE LIGAMENT.—An elastic, elongate, corneous structure that unites the two valves of the shell above the hinge plate (Plate 2, fig. 5).

DORSAL MUSCLES.—Muscles extending from the mantle into the umbonal cavity; these aid in retraction of the mantle.

DORSAL MUSCLE SCARS.—Impressions in the nacreous portion of the valve, formed by the attachment of the dorsal muscles; situated in the umbonal cavity (Plate 2, fig. 5).

DORSOPOSTERIOR SLOPE.—The area across the dorsal portion of the valve extending from the umbo to the posterior margin.

EDENTULOUS.—Said of shells lacking both lateral and pseudocardinal teeth.

EPIDERMIS.—The most external (and corneous) layer of the shell. See PERIOSTRACUM.

EQUIPARTITE.—Said of shells that have the umbo situated an equal distance from the anterior and from the posterior margins.

EXCURRENT SIPHON.—The modified tubelike posterior portion of the mantle that allows the exit of water and wastes from the animal; situated dorsal to the incurrent siphon.

FLUTINGS.—A series of undulations on the dorsoposterior portion of certain unionid shells; example, *Lasmigona costata* (Plate 20).

FOOT.—The ventralmost portion of a pelecypod; in unionid mussels it is essentially a locomotor organ (Plate 3, fig. 1).

GAPE.—Said of certain unionid shells that have a noticeable space between the valves, when the two valves are appressed as closely as possible.

GLOBOSE.—Said of shells that are nearly spherical or globular in shape.

GROWTH LINES.—Indiscrete lines of temporarily arrested growth appearing on the epidermis of the shell.

HINGE LINE.—The dorsal area of the shell that forms the pivot upon which the two valves rotate as they open.

HINGE PLATE.—The dorsal tooth-bearing surfaces of the two valves.

HYPOSTRACUM.—A layer of nacreous material deposited in the muscle scars of most unionids.

IMPERFECT.—Said of unionids that do not have well developed lateral or pseudocardinal teeth; example, *Strophitus rugosus*.

INCURRENT SIPHON.—The modified tubular posterior portion of the mantle that allows the entrance of water and food into the animal; situated ventral to the excurrent siphon.

INEQUIPARTITE.—Said of shells that have the umbones situated nearer to the anterior margin than to the posterior margin.

INFLATED.—Said of unionid shells that are greatly swollen.

INNER LAYER.—That portion of the shell deposited adjacent to the mantle. See NACRE.

INTERDENTUM.—A flattened area of the hinge plate between the pseudocardinal and lateral teeth of some unionid shells.

KANSAN.—Applied to the second of a series of glacial stages in the Pleistocene epoch (Ice Age). It may have begun as long ago as 500,000 years.

KNOB.—Protuberance or boss (usually exceeding 3 mm. in height) on the surface of a unionid shell (Plate 2, fig. 1). Knobs usually are large in size and few in number, whereas pustules are usually small and numerous.

LABIAL PALPI.—Fingerlike, ciliated appendages on either side of the mouth of the unionid; they aid in transferring food to the mouth.

LACHRYMOSE.—Said of pustules that are tear-drop in shape, as in *Quadrula quadrula* (Plate 2, fig. 3).

LAMELLA.—A thin plate or layer.

LANCEOLATE.—Said of structures that are narrow and that taper to a point at the apex.

LATERAL RIDGE.—An elevated part of the unionid shell near the center of the valve, extending from the umbo to near the ventral margin.

LIGAMENT.—See DORSAL HINGE LIGAMENT.

LATERAL TEETH.—Elongate, raised, interlocking structures on the hinge line of the valve, posterior to the umbo.

LUNULE.—Depressed area of some unionid shells immediately anterior to the umbo.

MALACOLOGIST.—One who studies mollusks.

MANTLE.—Two lobes of tissue extending from the body of a mussel; they envelope the body and are applied to the inner surfaces of the two valves.

MARSUPIAL SWELLING.—An enlarged or inflated ventroposterior part of the shell of the female unionid, that provides space for the expansion of the gills while they are carrying glochidia.

MARSUPIUM.—In unionids, a brood-pouch for eggs and larvae, formed by one or more gills.

MIDDLE LAYER.—See PRISMATIC LAYER.

MONOTYPIC GENUS.—A genus that contains but one species.

NACRE.—The iridescent, inner layer of a unionid shell, composed chiefly of calcium carbonate, and deposited in thin, overlapping lamellae (mother-of-pearl).

NEPIONIC SHELL.—The remains of the embryonic shell at the apex of the umbo.

OBSOLETE.—Said of structures that are lacking or indistinctly developed.

OPISTHODETIC.—Said of unionids in which the dorsal hinge ligament is posterior to the umbones.

OSTIUM.—A small opening; here refers to the entrance of a water tubule in the gills of the unionid.

OTOCYST.—An organ used by mussels for balance and orientation in the field of gravity.

PALLIAL LINE.—A linear impression approximately parallel to the ventral margin of the valve produced by the attachment of muscles extending from the mantle to the shell.

PAPILLA.—Small fingerlike projection on the posterior margin of the unionid mantle.

PALLIUM.—See MANTLE.

PERIOSTRACUM.—See EPIDERMIS.

PLACENTA.—The gelatinous substance forming an envelope around one or more developing glochidia in a water tubule within the marsupial gill.

PLANKTON.—Minute, aquatic plants and animals, having weak powers of locomotion, that form the principal food of mussels.

PLEISTOCENE.—A geologic period of time estimated to have begun approximately one million years ago and extending into recent times.

PLICATIONS.—Parallel ridges on the surface of a unionid shell.

PLIOCENE.—The geologic period of several million years duration immediately before the Pleistocene.

POST-BASAL AREA.—That area of the shell near the posteroventral margin of the shell.

POSTERIOR ADDUCTOR MUSCLE.—The largest of the muscles at the posterior part of the unionid body; responsible, in part, for the closure of the valves (Plate 3, fig. 3).

POSTERIOR ADDUCTOR MUSCLE SCAR.—A large impression in the nacreous layer near the posterior end of the valve, forming the attachment of the posterior adductor muscle (Plate 2, fig. 5).

POSTERIOR RETRACTOR MUSCLE.—A small muscle near the posterior end of the unionid animal that aids in retracting the foot of the mussel (Plate 3, fig. 3).

POSTERIOR RETRACTOR MUSCLE SCAR.—The smaller of the two impressions in the nacre near the posterior end of the valve, forming the attachment of the posterior retractor muscle (Plate 2, fig. 5).

POSTERIOR RIDGE.—A low ridge on the shell, extending from the umbo to the posterior margin.

POSTERIOR SLOPE.—See DORSOPOSTERIOR SLOPE.

POSTERIOR WING.—A dorsal extension of the shell above the hinge line, posterior to the umbo.

PRISMATIC LAYER.—The calcareous, prismatically organized part of a unionid shell, situated between the outer corneous periostracum and the inner nacreous layers.

PROTOTYPE.—An (usually hypothetical) ancestral form from which later groups of animals are derived.

PSEUDOCARDINAL TOOTH.—Any one of the triangular hinge teeth near the dorsal margin of the shell; situated ventral to the umbo.

PUSTULES.—Small, usually numerous, raised structures on the external part of the shell.

RADULA.—A tonguelike organ in the mouth of gastropods having numerous transverse rows of minute teeth; it is lacking in pelecypods.

REST PERIODS.—Thin, dark lines in the epidermis of the shell denoting approximately one season's growth (Plate 2, fig. 1).

RETUSE.—Said of shells that have a rounded anterior or posterior margin.

RIB.—A raised portion of a unionid shell extending from the umbo to the ventral or ventroposterior margin. See LATERAL RIDGE (Plate 2, fig. 3).

SCAR.—See CICATRICE.

SECCHI DISC.—A standard painted disc used for estimating the depth of the penetration of light into water.

SECONDARY SEXUAL VARIATION.—Said of unionids that have the post-basal region of the shell of females inflated in contrast to the shells of males that are not inflated in the post-basal region.

SINUS.—A cavity or hole. A feature of certain unionid shells that have a depression above or below the posterior ridge.

SOLID.—Said of shells that are thick and heavy.

SOLID HINGE LINE.—Said of shells having massive lateral and pseudocardinal teeth.

SOLID TEETH.—Lateral and pseudocardinal teeth that are large and massive.

SPECIES.—Groups of interbreeding natural populations that are reproductively isolated from other such groups.

SUBSPECIES.—A geographically defined aggregate of local populations within a species that differs morphologically and/or physiologically from other aggregations of local populations within the species.

SULCATE.—Said of shells that have a deep depression between the two pseudocardinal teeth of a valve.

SUPRABRANCHIAL CHAMBER.—The dorsal portion of the gills of a mussel from which water and wastes are passed to the excurrent siphon.

SURFACE SCULPTURE.—The pattern of ridges or pustules on the outer surface of the unionid shell.

TERTIARY.—A geologic period of time starting approximately 70 million years ago and terminated by the beginning of the Pleistocene epoch.

THERMOCLINE.—Sudden drop in the temperature at lower depths of water in lakes and ponds.

TRANS-MISSISSIPPIAN.—That region of the United States west of the Mississippi River and east of the Rocky Mountains.

TRIASSIC.—A geologic period of time starting approximately 200 million years ago and lasting approximately 35 million years.

TRUNCATE.—Said of shells having the end of the shell more or less at right angles to the dorsal and ventral margins.

TUBERCLE.—Small, rounded, raised structure on the outer surface of the unionid shell.

TYPE LOCALITY.—The precise locality from which a zoological object (type) that serves as the reference for the name of a species or subspecies is obtained.

UMBO.—The dorsally raised, inflated area of the unionid shell (Plate 2, fig. 1).

UMBONAL CAVITY.—The pit or cavity resulting from the dorsal extension of the umbones. It is situated lateral to the hinge line (Plate 2, fig. 4).

VALVE.—The right or the left half of a unionid shell.

VENTRAL FOOD GROOVE.—The specialized ventral portion of the unionid gill modified to transport food anteriorly to the mouth.

WATER TUBES.—Channels in the gills of the unionid for transporting water dorsally through the gill.

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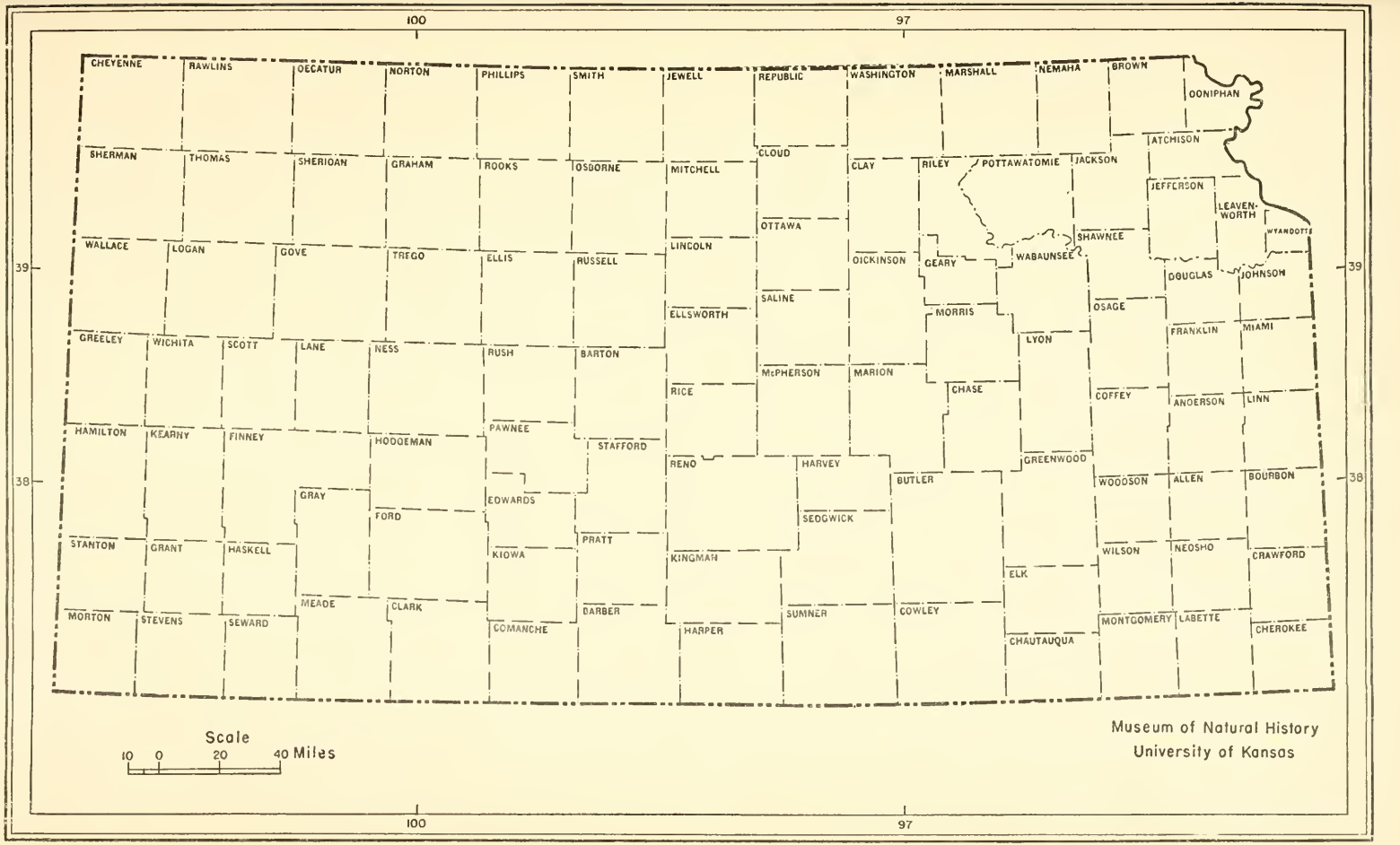

FIG. 42. Map of Kansas showing names of the counties.

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